ARMY TECHNOLOGY

MARCH/APRIL 2015 | VOLUME 3, ISSUE 2

A publication of science and technology news from the U.S. Army Research, Development and Engineering Command

FOCUS: AVIATION

+PLUS

INTERVIEW WITH

MAJ. GEN. JIM RICHARDSON AMCOM COMMANDING GENERAL

MARCH/APRIL 2015 | VOLUME 3, ISSUE 2

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DEPARTMENTS

ACRONYM GUIDE

AMC	U.S. Army Materiel Command
RDECOM	U.S. Army Research, Development and Engineering Command
ARL	Army Research Laboratory
ARDEC	Armament Research, Development and Engineering Center
AMRDEC	Aviation and Missile Research, Development and Engineering Center
CERDEC	Communications-Electronics Research, Development and Engineering Center
ECBC	Edgewood Chemical Biological Center
NSRDEC	Natick Soldier Research, Development and Engineering Center
TARDEC	Tank Automotive Research, Development and Engineering Center
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ARCIC	Army Capabilities Integration Center
DARPA	Defense Advanced Research Projects Agency
DASA(R&T)	Deputy Assistant Secretary of the Army for Research and Technology
AMCOM	U.S. Army Aviation and Missile Command
PEO Aviation	Program Executive Office Aviation

Maj. Gen. John F. Wharton, commanding general of the U.S. Army Research, Development and Engineering Command, stands with BEYA STEM Conference award winners from RDECOM in Washington, Feb. 6, 2015. From left: Doretha Green, Jean Christian Brutus, Dr. Cyril Williams, Maj. Gen. John F. Wharton, Fernando (Rios) Merritt, Ifeanyi Igwulu. (U.S. Army photo by Conrad Johnson)

Front cover design by Joe Stephens and AMRDEC VizLab. Back cover by Joe Stephens.

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Aviation is a foundational capability the Army brings to the joint force to prevent conflict, shape security environments and dominate the battlefield. As the Army rebalances toward the Pacific, faces unpredictable adversaries in the Middle East and supports aid to Ebola victims in Africa, we see that it would be difficult for the Army to realize its goal of a regionally aligned and globally responsive force without a robust aviation force. Aviation is key to our ability to accomplish a wide range of missions in these complex environments, as well as being a cornerstone of Army lethality.

The Army has an amazing history with aviation. Aviation platforms have remained in service for 40 to 60 years. The pace of change is accelerating, however, and technology formerly reserved to major powers is spreading. Future challenges such as operating in megacities or against subterranean objectives makes the battlefield agility and lethality afforded by Army aviation all the more important.

> "Our goal is to improve aircraft performance and survivability, and significantly reduce operating costs."
>
> **– Maj. Gen. John F. Wharton**

In response to these challenges, the U.S. Army is leading Department of Defense rotorcraft development efforts. Future Vertical Lift, known as FVL, is an initiative to develop the next generation of vertical lift aircraft for the Joint Warfighter Program.

Our goal is to improve aircraft performance and survivability, and significantly reduce operating costs. This will help the aircraft fly farther and faster, carry heavier payloads, team with unmanned systems and perform optionally piloted missions. We will also ensure our aviation capabilities meet the Army Materiel Command goal of sustainable readiness by making them easier and less expensive to sustain, which will increase their mission availability and the resources we have to develop future capabilities.

The command manages the Joint Multi-Role Technology Demonstrator, known as JMR TD. The goal of the program is to provide the foundation to replace the Army's aviation fleet over the next 25 to 40 years. To that end, RDECOM's Aviation and Missile Research Development and Engineering Center team at Redstone Arsenal, Alabama, is working with industry partners toward a goal to design and build demonstrator aircraft in 2018. This will allow us to mature the necessary technologies and reduce the risk associated with future vertical lift.

This edition of the magazine highlights aviation technology advances that will provide a greater capability to overcome the constraints of complex terrain, higher altitudes, extreme temperatures and extended distances. These are all necessary components of the Army's goal of a regionally aligned and globally responsive force.

The center of mass for aviation research, development and engineering is at AMRDEC, but the command's other centers are also engaged. The Army Research Laboratory is developing a futuristic dashboard concept that is sure to change Army aviation, and perhaps commercial aviation as well.

Protecting our aircrews is a high priority. Our team at the U.S. Army Edgewood Chemical Biological Center is optimizing the aircrew individual protective mask. Our Armament Research, Development and Engineering Center is developing ways to protect aircrews from surface-to-air missiles.

Maj. Gen. John F. Wharton
Commanding General
RDECOM

Bio: http://www.army.mil/article/134110/

At the Soldier Research, Development and Engineering Center we are developing innovative parachute delivery systems. At the Communications-Electronics Research, Development and Engineering Center, we're working closely with the Program Executive Office for Command, Control and Communications-Tactical to ensure our Unmanned Aircraft Systems, or UAS, are integrated into the network. True integration of manned and unmanned teaming and optionally piloted vehicles will provide new options for reconnaissance, security and logistics.

Army research and engineering efforts will lead to better speed, range, payload and mission systems that are critical for our success in future operational environments.

ARMY TECHNOLOGY

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Future of Army Aviation

MAJ. GEN. JIM RICHARDSON IS THE COMMANDING GENERAL OF U.S. ARMY AVIATION AND MISSILE COMMAND

The U.S. Army Aviation and Missile Command at Redstone Arsenal, Alabama, supports the joint warfighter and American allies by ensuring aviation and missile readiness with seamless transition to combat operations. Maj. Gen. Jim Richardson commands the organization of 8,000 civilian workers and 175 soldiers. AMCOM performs vital work on aviation and missile systems and the supporting equipment required to operate them. He is a native of Myrtle Beach, South Carolina, and a 1982 graduate of the University of South Carolina. Richardson holds a master of science in Advanced Military Studies from the Command and General Staff College, as well as a master of science in National Security and Strategic Studies from the National Defense University. He is a graduate of the Armor Officer Basic and Aviation Officer Advanced Courses, the Army's Command and General Staff College, School of Advanced Military Studies, and the National War College. He has served as deputy commanding general of III Corps and Fort Hood, Texas, and while deployed he served as deputy commanding general, U.S. Forces Afghanistan, and commander of the U.S. National Support Element.

Army Technology: Please discuss the role of technology in Army aviation and how it has strengthened the U.S. Army in the past decade of war?

Richardson: Aviation is constantly striving to provide better support to the warfighter through technological advances. As the war changed over the years we had to adapt to meet the challenges of an evolving enemy. We have been able to meet these changing battlefield requirements largely thanks to technological advances in multiple facets of aviation.

Situational awareness on the battlefield is an area that immediately comes to mind where technology safeguards the lives of our Soldiers and makes aviation assets more effective. The pilot's situational awareness is enhanced through the use of systems such as Blue Force Tracker to provide real-time updates of locations of friendly and enemy forces, civilians, and key terrain. The use and integration of UAVs [unmanned aerial vehicles] also enhances our ability to obtain situational awareness on the battlefield. Systems such as Manned/Unmanned Teaming allows a pilot to receive a UAV's video feed in the cockpit while the higher headquarters monitors as well. This provides pilots and commanders with the ability to make better decisions and minimize the chances of incidents that degrade the efforts of U.S. Forces.

We match technology with intensive, realistic, high-quality training to produce aviators who can use these improved systems and provide support to ground forces. Our greatest assets are our Soldiers. Technology enhances their ability to meet mission requirements.

Army Technology: What do you want to see in the future regarding aviation advances?

Richardson: Future Vertical Lift is the Army's program to produce the next generation of Army rotary-winged aircraft. The Army is actively participating in the Department of Defense' Joint Multi-Role program in order to develop common architectures and modular mission equipment to meet a wide array of requirements with a reduced need for infrastructure in order to support maintenance requirements for different variants.

The Improved Turbine Engine Program is a current program that will create the future of Army aviation engines. It is a major advance in military helicopter technology and will allow AH-64s and UH-60s the ability to carry more armament and more troops further and more efficiently. The ITEP will allow our future aircraft to operate with more flexibility while increasing effectiveness on the battlefield. ITEP, when paired with FVL aircraft, provide us the opportunity to see the future of Army aviation.

Continued improvement of existing systems is required to maintain our technological advantage as well. Improvements to Forward Looking Infrared systems, avionics, night vision capabilities, etc. will continue concurrently with other advances to provide pilots and crews with the best equipment our nation has to support our Soldiers.

Army Technology: How will advances in aviation technology enable the Army to win in a complex world?

Richardson: The aviation advances taking place are greatly improving our ability to be adaptable and flexible in a changing operational environment. As our forces reduce and budgetary restrictions increase, it is extremely important for us invest in technologies that allow us to maximize the assets available. Enhanced communications allow for a better integrated force and provide increased situational awareness. Operational requirements will continue to change and our technological advances will make it possible for us to meet these challenges head on. The training our Soldiers receive will maximize their ability to use these new systems.

Army Technology: What do you expect from Army researchers and engineers? How do you partner with them?

Richardson: First, I would like to thank our researchers, engineers and the Army's S&T community for the outstanding work they do to safeguard our Soldiers and provide them with the best equipment possible. The importance of their work cannot be overstated. As a commander, I know firsthand the impact of American technology on the battlefield. The aircraft in my unit took battle damage on multiple occasions, but it was the solid engineering that protected the Soldiers inside and later, that kept the aircraft flying to complete our missions.

AMCOM partners with engineers constantly to meet our mission requirements. We have to be responsive and proactive in our approach to delivering readiness to the warfighter and the only way we can do this is as a part of a team. The engineers provide us with the technical expertise to accomplish this daunting task.

As the material release authority for the Army, I rely on my engineers every day to provide me with an engineering assessment of the equipment before I make a decision on the safety for our Soldiers. They are an integral part of my decision-making process. Nothing is a higher priority than safeguarding the lives of our Soldiers, without the work engineers are doing we could not accomplish this core task.

Army Technology: How will the Army be able to meet its vision for the future of aviation and continue to be good stewards of resources?

Richardson: With increased budgetary restrictions we must streamline our processes to ensure we are being good stewards as we transition from an Army at war. AMCOM is working toward reduced costs with initiatives such as the increased use of condition based maintenance, with its multiple aircraft sensors to assess maintenance requirements instead of replacing components based on time or other metrics. Used properly, CBM could reduce costs to units substantially. We have also improved the training our Logistics Assistance Representatives receive in order to reduce our reliance on Contract Field Support Representatives. An AMCOM LAR is fully capable of accomplishing the tasks of a CFSR at no cost to the unit. The Army is dedicated to meeting requirements for the future of aviation while reducing costs and we will all do our parts to make this a reality.

Army Technology: How concerned are you with the lifecycles of the Army's current aviation platforms? Why is it critical that the Army research potential replacements?

Richardson: One of AMCOM's major responsibilities is delivering readiness throughout the lifecycle of the aviation platform. Currently we provide services to support and extend the entire lifecycle such as reset and recapitalization to essentially return an aircraft to zero flight hours. This provides a unit with what amounts to a new aircraft reducing the need for acquisition of additional aircraft as replacements. This also results in a substantial savings over the purchase of new aircraft.

U.S. Army Commanding General Maj. Gen. Jim Richardson, Aviation and Missile Command, receives a briefing at the Aviation Flight Test Directorate, Redstone Arsenal, Alabama in June, 2014. (U.S. Army photo by Ann Jensis-Dale)

The Army must continue to prepare for future threats. Improvements to our current platforms and replacements of aircraft are ways to ensure our continued technological advantage on the battlefield. With upgrades and replacements being explored, AMCOM must continually meet maintenance demands that arise. The Army must continue to research replacements to ensure the best technology and capabilities are available for our Soldiers. Extensions to the lifetime of the current platforms provide savings and the ability to better incorporate emerging technologies into current and future platforms. AMCOM will continue to do everything it can to provide longevity to the existing fleet while preparing to meet maintenance requirements of future aircraft.

Army Technology: How is the AMCOM workforce positioned to continue aviation support to the Army of 2025 and beyond?

Richardson: AMCOM's entire workforce is dedicated to lasting support now and into the future. We have personnel deployed around the world to provide aviation support and will continue to meet the maintenance needs of units conducting training and contingency operations.

We recently prepared a plan to ensure the support we provide will meet the maintenance requirements of our force as the Army changes. This started with a new mission statement and vision to ensure our focus as an organization was in the right place. From there we refined our core competencies to make certain we were fundamentally prepared for the current environment while remaining flexible in order to meet future requirements.

Our organic industrial base is key to the support AMCOM provides. The AMCOM depots located at Corpus Christi, Texas, and Letterkenny, Pennsylvania, are national treasures and are a critical asset in providing continued aviation support into the future. They ensure AMCOM is using state-of-the-art materials, techniques and processes to maintain a modern aviation fleet. This base is coupled with a talented and experienced workforce dedicated to providing the best equipment to our warfighter. We are focused on recruiting and retaining the right people to support our vision and the Army as we move forward. We need to right-size our workforce against our workload while ensuring we have the infrastructure and flexibility to meet emerging threats should they arise.

Future Vertical Lift Program

WHAT IS IT?

The U.S. Army is leading the Department of Defense's revolutionary approach to aviation development with Future Vertical Lift, known as FVL, an initiative to develop the next generation of vertical lift aircraft for the Joint Warfighter Program. The tenets are to improve aircraft performance and survivability, and to significantly reduce operating costs. This will help the aircraft to fly farther and faster, carry heavier payloads, be easier and less expensive to sustain, team with unmanned systems, and perform certain optionally piloted missions. The FVL family of aircraft share common hardware such as sensors, avionics, engines and countermeasures.

WHY IS THIS IMPORTANT TO THE ARMY?

The U.S. vertical lift fleet is aging, and history indicates that platforms remain in service for 40 to 60 years. FVL provides the necessary foundation to replace the fleet over the next 25 to 40 years. FVL platforms will provide a greater capability to overcome the constraints of complex terrain, higher altitudes, extreme temperatures and extended distances. True integration of manned and unmanned teaming and optionally piloted vehicles will provide new options for reconnaissance, security and logistics. FVL will provide the speed, range, payload and mission systems critical for success in future operational environments.

WHAT HAS THE ARMY DONE?

The Aviation and Missile Research, Development and Engineering Center, a U.S. Army Materiel Command element of the Research, Development and Engineering Command, manages the Joint Multi-Role Technology Demonstrator, a science and technology program to design and build flight demonstrator aircraft with the intent of maturing required technologies and reducing risk parameters associated with FVL.

In 2013, AMRDEC announced the award of four technology investment agreements to industry partners to demonstrate an operationally representative mix of capabilities to investigate realistic design trades and enabling technologies. The initial designs will be refined to make preparations toward potentially building and flight testing a demonstrator aircraft in 2017.

WHAT EFFORTS DOES THE ARMY PLAN TO CONTINUE IN THE FUTURE?

The JMR-TD contains an air vehicle demonstration and a mission systems architecture demonstration. They will prepare DOD for material solution decisions and keep the country's rotorcraft industrial base engaged and aligned with the DOD FVL initiative. The integration of the JMR-TD into the overall requirements and acquisition process will inform what is feasible, achievable and affordable. To ensure a seamless transition, AMRDEC's Aviation Development Directorate, in collaboration with Program Executive Office Aviation, is developing the office that will eventually manage the FVL acquisition program.

FOCUS QUOTE

"Aviators have been and will continue to be integral in every success we will achieve. As we wind down from 13-plus years of war, we all hoped the world environment would cooperate and stabilize—in reality, there is no peace dividend—the world has changed and it requires the United States Army to remain globally engaged while at the same time operating with a smaller budget and force structure in a world that is as dangerous as I have seen."

— **Army Vice Chief of Staff Gen. Daniel B. Allyn**

Above: *Sikorsky and Boeing have worked together on their offering for the U.S. Army's joint multi-role technology demonstrator called the SB-1 Defiant. (Artist's rendering courtesy Sikorsky-Boeing)*

Below: *The tiltrotor V-280 Valor aircraft is Bell Helicopter's vision of the future as it prepares for flight demonstrations for the U.S. Army in 2017. (Artist's rendering courtesy Bell Helicopter)*

Future of Army Aviation Research

(U.S. Army photo by Russ Wetzel)

Interview with aviation researcher Dr. Bill Lewis

Dr. Bill Lewis is the director of the Aviation Development Directorate for the U.S. Army Aviation and Missile Research and Development Center at Redstone Arsenal, Alabama. He manages and directs the execution of the Army Aviation Science and Technology portfolio, including basic and applied research, and advanced technology development. A career Army Aviator and experimental test pilot, his duties also include serving as the Office of the Secretary of Defense lead for rotorcraft technology, and as director of the National Rotorcraft Technology Center.

Army Technology: What is the focus of Aviation science and technology research?

Lewis: The primary mission of the aviation development group is to formulate the technology advances that we're going to implement in the future, both for current fleet and future fleet. This includes upgrades of our current fleet, development of new air vehicles, both manned and unmanned, as we progress toward the future of vertical lift.

Army Technology: What are some significant programs in AMRDEC's current portfolio?

Lewis: Our two most visible programs are the Joint Multi-role and Degraded Visual Environment Mitigation. JMR is the S&T precursor to the Future Vertical Lift program; a family of rotorcraft vehicles. In the DVE-M program we are developing a new warfighting capability by exploiting adverse environments. Remember, however, that 50 percent of our portfolio supports the current fleet. Management of the portfolio is through focus areas including basic research, aircraft design, platforms, propulsion/drives, mission systems and sustainability. We must maintain the technical advantage for today's fight while the future fleet is being developed.

Army Technology: How significant will aviation assets be on the future battlefield?

Lewis: Since the advent of air mobility concepts of the early 1960s, aviation has been increasingly important to land warfare. In our recent engagements in Iraq and Afghanistan, aviation assets were huge enablers on the battlefield. As we progress to a more expeditionary force, an essential component will be more capable air assets. I can't envision an expeditionary force that doesn't include aircraft capable of self deployment and extended range operations.

Army Technology: What makes this mission difficult?

Lewis: Several things. Obviously the technical advancements in the aerospace community are a constant challenge. This is compounded by the niche sector in rotorcraft being broadly underfunded. We have the right workforce to lead the sector into the future for the aerospace components. However, aviation is not all about aerospace. As we become more dependent on digital capabilities in our aircraft, the complexity of the integrated product increases from a development and qualification perspective. We rely on significant collaboration from other elements of the U.S. Army Research, Development and Engineering Command to support these collective tasks.

Finally, S&T is a futures game. It is difficult to find resident aviation futurists. Many are encumbered by their present equipment and operational concepts. It is difficult to divorce yourself from the present and consider new ways of conducting the future battle.

Army Technology: You mentioned collaboration. Could you expand on those efforts?

Lewis: The rotorcraft community is highly collaborative. It includes DOD, NASA, DARPA, academia and industry. We have a significant international involvement including NATO, The Technical Cooperative Program and country specific program agreements. We have three centers of excellence, including Georgia Tech, University of Maryland and Penn State. Our industry partners actively exchange information and teaming through the NRTC and the Vertical Lift Consortium. We develop a consolidated Strategic S&T Plan that is integrated with the acquisition Long-Range Investments Requirements Analysis. Detailed collaborative efforts occur within our technical solution space. Many of these are within RDECOM. Cooperative efforts with other service research labs, NASA and DARPA are plentiful.

Army Technology: Can you provide a little information about your unique organization?

Lewis: The Aviation Development Directorate is a geographically dispersed, virtual organization. It is headquartered at Redstone Arsenal, Alabama with a handful of people. The major components are located at Joint Base Langley-Eustis (Aviation Applied Technology Directorate) and Moffett Field, California (Aero Flight Dynamics Directorate). AFDD is co-located with major NASA aerodynamic infrastructure, and wind tunnels. When someone asked the question, "Can we bolt an M-1 rifle onto a Cessna O-1 Bird Dog?" back in 1948, AATD was born at the Transportation Center to solve that problem. Since that time we have been conducting aviation Prototype Integration Facility work to solve applied engineering problems. I do not see the geographical issue changing due to the above rationale. That means we need to close the virtual gap by emphasizing reductions in operational and affinity distance. This is accomplished largely by optimizing communications, standardizing procedures and building trust.

This really gets back to the workforce and we have a great team. Our education ranges from PhD to GED; our specialties from scientific engineering to tradesman, from experimental test pilot to maintenance technician. We are able to discover a technology or application, develop a product to test, demonstrate the application and deliver the invention to the Soldier; all within this one organization. We could not accomplish this feat or operate as a virtual organization without the right mix of specialties and personalities within ADD. Our workforce continues to successfully accomplish this complex mission due to their broad capabilities and outstanding motivation to support soldiers.

Army Technology: Where do you see the aviation fleet in the year 2050?

Lewis: Before we begin that discussion, I want to emphasize the priority of our efforts are to the Soldiers in the fight tonight. We must keep our current fleet relevant and capable for the foreseeable future. When we field our first combat aviation brigade equipped with future platforms, there will still be 3,000 Apaches and Black Hawks in the fleet.

The technology of the future will support our Soldiers across a wide range of missions with increased capabilities. The aircrew of the future will rely upon extensive automation and have access to improved situational awareness, allowing them to respond to an evolving and complex battlefield. Future vertical lift aircraft will fly further, faster and perform in a wider range of environmental conditions while carrying heavier payloads. Aircraft may be manned or unmanned, flight operations will be automated, and the pilot will assume more of a "mission commander" role. The aircraft will require far less maintenance and sustainment; near zero effort. Autonomous vehicles will perform various mission tasks and provide the commander greater flexibility for mission accomplishment. ■

Defining the FUTURE AVIATION FLEET

Army scientists, engineers lead joint effort

BY DAN LAFONTAINE, RDECOM PUBLIC AFFAIRS

Artist's conception of future Army rotorcraft. (U.S. Army graphic by AMRDEC VizLab)

The U.S. Army science and technology community is charting the future of military vertical lift aviation that will enable warfighters to accomplish missions not possible today.

The Army, supported by NASA and the Navy, is combining its areas of technical expertise to accomplish the aggressive scientific and engineering goals necessary to develop a new fleet of joint aircraft, said Ned Chase, deputy program director of S&T for the Joint Multi-Role Technology Demonstrator/Future Vertical Lift.

JMR TD has been established to address several of the capability gaps that cannot be satisfied by updating the current fleet.

"Let's figure out what we want this new aircraft to do, and let's go out and prove that we have the technologies available to meet those requirements. That's what we're doing with JMR TD," said Chase, with the Army Aviation and Missile Research, Development and Engineering Center at Fort Eustis, Virginia.

The Department of Defense is using JMR TD to design and integrate the technologies that will eventually feed into FVL and replace the military's vertical lift fleet with a new family of aircraft.

LEVERAGING EXPERTISE FROM ACROSS ARMY S&T

AMRDEC, one of seven centers and laboratories that make up the Army Research, Development and Engineering Command, is leading the S&T effort. Chase and his team are working closely with fellow scientists and engineers within RDECOM to conceptualize, research and design the many technologies that will be necessary for this future vertical lift capability.

AMRDEC will leverage its expertise in aviation; however, the team will rely upon its peer organizations for the complementary pieces. For example, RDECOM's Communications-Electronics Research, Development and Engineering Center at APG is the expert in areas such as communications systems, sensors and cameras, he said.

"The one thing that we've not done in quite a long time was demonstrate that we can build an aircraft from scratch that incorporates the individual technologies that we've been working on the past 25 years," Chase said. "We have the capacity across AMRDEC to populate the aircraft with the right components—engines, rotors, structures, flight controls.

"We want to put together a roadmap to develop the radios, weapons, sensors and survivability equipment by drawing from RDECOM in preparation for FVL. We take their products and integrate them onto the platform itself. FVL is going to reflect the aggregate of RDECOM investment."

Charles Catterall, AMRDEC lead systems engineer, has worked to develop an S&T integrated product team in order to build an investment strategy across RDECOM.

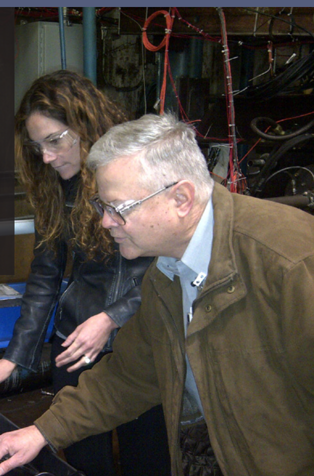
"We are engaging our sister organizations within RDECOM. What can the command do to support this program? What resources can be brought to bear to facilitate and support this Future Vertical Lift initiative with technologies? Given a clean sheet, could you bring additional capabilities to bear? We're looking across the command," Catterall said.

Catterall explained that JMR TD has two components—the Air Vehicle Demonstration, or AVD,

ADVANCED ROTORCRAFT

Team effort drives advanced rotorcraft

BY CARLOTTA MANEICE, AMRDEC PUBLIC AFFAIRS



Andrea Chavez and Keith Hale, of Bell Helicopter, test the supercritical drive shaft developed under AMRDEC's Future Advanced Rotorcraft Drive System program. (U.S. Army photo)

The U.S. Army Aviation and Missile Research, Development and Engineering Center has partnered with Bell Helicopter and the Sikorsky Aircraft Corporation in a cooperative technology investment agreement with the Future Advanced Rotorcraft Drive System Programs.

These programs focus on the critical performance and affordability enhancing drive system technologies for the Army's current and future force fleet of rotorcraft, as well as commercial rotorcraft.

AMRDEC's Aviation Applied Technology Directorate works closely with the Bell FARDS program and the Sikorsky program to increase the drive system power-to-weight ratio, reduce production, operating and support costs, reduce noise and automatically detect critical failures.

Both programs have met FARDS objectives through the development of several enabling technologies, and program costs are shared between the government and industry.

Government programs such as the Small Business Innovative Research and Small Business Technology Transfer programs enable new technologies to be developed.

"Being able to leverage the technologies developed by these small businesses and nonprofit research institutions allows us to meet the aggressive program goals for the FARDS program," said Jason Fetty, an aerospace engineer with AMRDEC.

Ferrium C64 is a gear steel material with a high hardness level. This material allows gears to run at high-load levels without failure and carry more loads through the gearbox. High-strength materials are needed so that the gears do not fail during high-load conditions.

Gearbox housing technologies developed under FARDS include topological optimization and 3-D digital definition employing additive manufacturing. Topological optimization methods are found to be successful in optimizing casting sizing, weight and features. Three-dimensional digital definition with additive manufacturing allows for modeling of casting pours, along with the creation of digitally defined molds. These technologies improve housing manufacturing and allow for a significant reduction in housing weight.

Supercritical drive shaft technology developed under FARDS improved existing rotorcraft drive shafts. Typically a tail rotor drive shaft is made up of several shaft segments and couplings and operates at a rotational speed below the shaft's first natural frequency, or critical speed. The supercritical shaft developed under FARDS operates above the third natural frequency and explores different materials, processes and bearing arrangements. The system requires fewer parts, resulting in reduced weight and cost.

The FARDS technologies are designed, fabricated and tested to demonstrate the program goals in a relevant environment.

"The FARDS technologies have the potential to not only significantly increase performance but also reduce costs for the Army's rotorcraft," Fetty said. "The cost share from industry allows for additional risk reduction testing, which furthers the technology readiness levels of the technologies. It also shows that industry has confidence in the commercial applications of the developed technologies."

The FARDS program will provide enabling drive system technologies for current rotorcraft as well as future platforms such as Future Vertical Lift. The improvements in durability will reduce the logistical support requirements and cost of ownership. New diagnostic capabilities will allow for transition to zero maintenance aircraft. The new FARDS diagnostic technologies are designed to detect more failures in a drive system than what can currently be detected. The Army plans to demonstrate the program goals by the end of 2015.

and Mission Systems Architecture Demonstration, or MSAD. Two contract teams—Sikorsky-Boeing and Bell Helicopter—are responsible for the design, analysis, fabrication, ground testing and ultimately, flight testing of the demonstrator aircraft.

The industry proposals for FVL include the capability to carry a payload of 12 troops and four crew, hover out of ground effect at an ambient condition of 6,000 feet and 95 degrees Fahrenheit, and self-deploy 2,100 nautical miles at a speed of at least 230 knots.

THE MSAD portion will integrate technology concepts from across RDECOM, as well as the Department of Defense, into an open, efficient, effective and enduring architecture.

The MSAD initiative will develop a standard reference architecture that can be used as the basis for design and implementation of an avionics architecture. This will enable hardware and software re-use across multiple mission design series aircraft and multiple vendor implementations, Chase said.

The knowledge, standards, processes and tools necessary to design and implement such a mission systems architecture that is affordable will be used to inform the government's generation of requirements for the anticipated FVL program.

Chase said that a major challenge for DoD scientists and engineers is to develop their specific pieces of technologies—whether sensors, weapons,

With twice the speed and range of conventional helicopters, the Bell V-280 would offer operational agility to self-deploy and perform a multitude of vertical lift missions. (Artist's renderings courtesy Bell Helicopter)

cameras or crew systems—and ensure they function correctly within a much more demanding future aviation environment than exists today.

"This future fleet will be faster and go farther. We're trying to ensure that the other [research centers] understand how the aviation environment and constraints change when we go from flying aircraft at 130 knots to 250 knots," Chase said. "The environment we're creating for weapons, sensors and radios is much different with FVL than the current fleet. FVL will operate in a different performance regime."

ARMY LEADS JOINT AVIATION PROGRAM

Developing a joint aircraft instead of a separate version for each service is expected to save time and money in technology development, training, maintenance and logistics, Chase said.

There are four classes of aircraft that have been identified for the fleet—light, medium, heavy and ultra.

"We want to develop technology applicable to each of the four basic aircraft of the FVL family, and then populate them with the mission equipment that is required to satisfy each of the service's missions," Chase said. "You're working from the same framework of requirements and technologies.

"You don't have to do individual technology developments for every single class of aircraft in the fleet. It's about efficiency of investments, costs and logistics."

Working with NASA and Navy scientists and engineers brings complementary expertise to the project, he said. Significantly different missions among the services require different skill sets among the aviation subject-matter experts.

"Because it is a joint requirement, it drives you to having a joint team. We have a mixed team to address a comprehensive requirement that neither the Army nor Navy S&T enterprise might be capable of solving entirely by itself," Chase said.

"The Army operates across land, and we have specific missions—air assaults, attack and reconnaissance. The Navy has a different challenge with operating on the ship, which drives the space that an aircraft can fit on and be maintained in. The Marines Corps has an expeditionary mindset where extended range is extremely important."

First flight testing is expected in summer 2017. The technologies to be integrated onto the platform should be at technology readiness level 6, or a prototype level, between 2022 and 2024.

While government agencies such as the Defense Advanced Research Projects Agency build single-purpose aircraft, Chase emphasized that the goal of JMR TD is to develop a fleet that will achieve several stringent goals.

"We're in pursuit of several aggressive individual requirements that in the aggregate is something way beyond what we can do today," Chase said. "We have to be able to operate all over the world, in any kind of environment, across a speed spectrum that allows us to do our mission anywhere, anytime." ■

FOCUS ON ROTORCRAFT

Scientists, researchers and aviators drive innovation

AMRDEC PUBLIC AFFAIRS

The Army rotorcraft of the future will depend on the imaginations and engineering prowess of scientists, researchers and aviators at the U.S. Army Research, Development and Engineering Center.

AMRDEC's Aviation Development Directorate maintains a deep portfolio of science and technology project looking at current and future rotorcraft, including survivability, performance and affordability.

Rusty Graves, the directorate's acting chief engineer, hopes to use science and technology to enhance the legacy fleet while supporting Future Vertical Lift until it transitions to the Program Executive Office Aviation.

"We manage and conduct basic and applied research, and advanced technology development to provide one-stop life cycle engineering and scientific support for aviation systems and platforms," Graves said.

AMRDEC divides the directorate's S&T efforts into six focus areas.

BASIC RESEARCH

Basic Research develops the fundamental understanding of vertical-lift phenomena that is the foundation of the more applied research in the other aviation focus areas. Understanding rotor aerodynamics and aeromechanics is our toughest challenge, said Dr. Mahendra Bhagwat, focus area lead.

Experimental work in the focus area involves investigations of rotor wakes and their interactional aerodynamics effects. Novel flow-control techniques are developed using plasma and fluidic actuators in order to reduce fuselage drag to eventually allow the aircraft to fly faster. The focus area also helps to validate advanced flow control and diagnostics through experimentation.

Computational work in the basic research focus area is the theoretical basis for S&T modeling and simulation capabilities. "Our computational aeromechanics team," Bhagwat said, "is developing a new grid-generation paradigm with strand grids. These grids allow the users to easily generate complete aircraft simulation models with sufficient resolution that is required to achieve the accurate and high-fidelity simulation that is essential to good design."

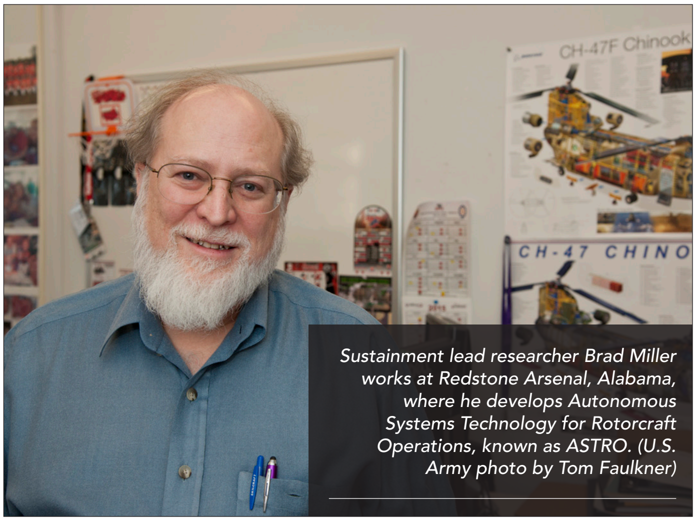
External research is supported through the Vertical Lift Research Centers of Excellence at the Georgia Institute of Technology, Pennsylvania State University and the University of Maryland. The centers do cutting-edge research in aeromechanics, structures, flight dynamics and control, design, concepts, vibration, noise control, propulsion, affordability and safety, while training future rotorcraft scientists and engineers.

DESIGN & ASSESSMENT

Bruce Tenney's Concept Design & Assessment focus area uses research from Bhagwat's focus area and its own tools and data to examine new conceptual designs from industry, brokering these with Army requirements staff. The focus area is now concentrating on medium, light and heavy versions of FVL, working with the joint FVL requirements team, which includes the services that would operate FVL.

For example, the focus area translates requirements for troops carried, speed, operating radius and takeoff capabilities into conceptual FVL designs. It has helped the Army understand that its desired capabilities may result in a very large aircraft.

Tenney's focus area will lay out the FVL family for the FVL requirements team in April.



Sustainment lead researcher Brad Miller works at Redstone Arsenal, Alabama, where he develops Autonomous Systems Technology for Rotorcraft Operations, known as ASTRO. (U.S. Army photo by Tom Faulkner)

"This focus area is also developing better computer-modelling tools to simulate unconventional configurations, for which there is no data," Tenney said. "This streamlines design, allowing adjustments earlier and more economically, and expands design options for all rotorcraft. Besides FVL, modelling can investigate legacy options such as putting a wing on the UH-60 Black Hawk."

PLATFORM

The Platform focus area hunts for improvements in aeromechanics, rotors, structures, vehicle management, flight controls and subsystems, all while decreasing vulnerability.

Lead researcher Jon Schuck's first priority is advanced configurations to reduce drag for future higher-speed rotorcraft. Active drag-reduction technologies will be tested by Computational Fluid Dynamics in wind tunnels and eventually flight.

Reliability is next, for which Schuck anticipates that certification methods for fixed-wing aircraft will be applied to rotorcraft. Using fly-by-wire techniques in rotorcraft should improve handling, reduce structural loads and lengthen useful lives.

"We seek survivability through internal and external airbags and advanced occupant restraints," Schuck said. "The Army will move toward crash prediction by using data that senses when a crash is unavoidable to pull crew into safer positions."

Schuck's ultimate objective is to ensure that, unless destroyed by superior force, a helicopter can continue the fight.

These innovations are much easier for new aircraft, but the Armament Research, Development and Engineering Center's Combat Tempered Platform Demonstrator intends to apply improvements to the next major Black Hawk upgrade.

POWER

The Power focus area works with engines and drive systems. Lead researcher Kevin Kerner seeks versatile, intelligent engines and drives that improve performance over wide operating ranges, enhance durability and reduce maintenance.

"We are looking at engines and drives with variable-output speed capability," Kerner said. "These will enable rotor speeds to vary so new aircraft configurations can perform better at high speed. Another initiative is investigating smart filtration, which would improve the reduce the impact of sand and dust on engines."

Smart filtration is operational when needed against sandy operating environments, but can be turned off for better engine performance when sand is not threatening.

The focus area also works on better diagnostics and prognostics to track engine and drive system health. By extending the maintenance intervals, these tools would increase aircraft availability and reduce maintenance cost, while still preventing catastrophic maintenance surprises.

Kerner said the variable speed technology is more easily appliedto engine designs for new airframes. The other two areas, smart filtration and improved prognostics, could be retrofitted on current airframes.

The directorate recently transitioned Advanced Affordable Turbine Engine technology to the Improved Turbine Engine Program, Kerner said.

SYSTEMS

The Missions Systems focus area is responsible for five areas:

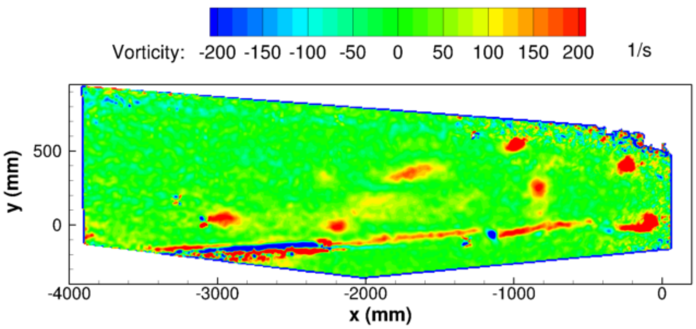
- Human-systems interface
- Engagements and effects (weapons and sensors)
- Survivability
- Avionics and networking

Teaming, autonomy and information management

"Information management includes software that runs in the background, assisting pilots in their decision making and making recommendations for pilot actions," said lead researcher Ray Wall.

This last area involves both manned and unmanned aircraft, he said.

The team is emphasizing handling degraded visual environments, or the brownouts or blackouts that can cause pilots to hit unseen obstacles or roll over after losing orientation due to



lack of visual clues.

"To mitigate these sorts of danger, we're working in three areas, modernized flight controls; advanced sensors for low visibility; and symbology, which would provide visual cues to pilots," Wall said.

Wall likened symbology to the modern automobile dashboards that give drivers necessary data in a quickly comprehensible format or to the equipment for instrument flight rule flying on aircraft.

The Missions focus area is now concentrating on FVL, but Wall said he also seeks to upgrade legacy aircraft, for example by enabling unmanned aircraft to fly as wingmen to manned rotorcraft.

SUSTAINMENT

The major current project is Autonomous System Technology for Rotorcraft Operations, known as ASTRO, which seeks the best technologies for Enhanced Condition Based Maintenance.

"ASTRO is a total-system approach, using automated data "reasoners" to assess system health of engines, drives, structures, rotors and electrical systems," said lead researcher Brad Miller.

Miller collaborates closely with Kerner on power-train diagnostics and Schuck's platform technical areas.

"Current health monitoring collects data for analysis by engineers," he said. "ASTRO will tell mechanics or pilots what is going on in aircraft and recommend actions before failure. It would translate temperature spikes, pressure changes, noises and vibrations into defects and remedies. The concept would be easier to design into FVL, but elements might be retrofitted on legacy aircraft."

Miller's goal for the second generation of FVL is zero maintenance, combining ultra-reliable, fatigue-free design, and next generation predictive health monitoring and assessment, to enable significant periods of maintenance-free operation.

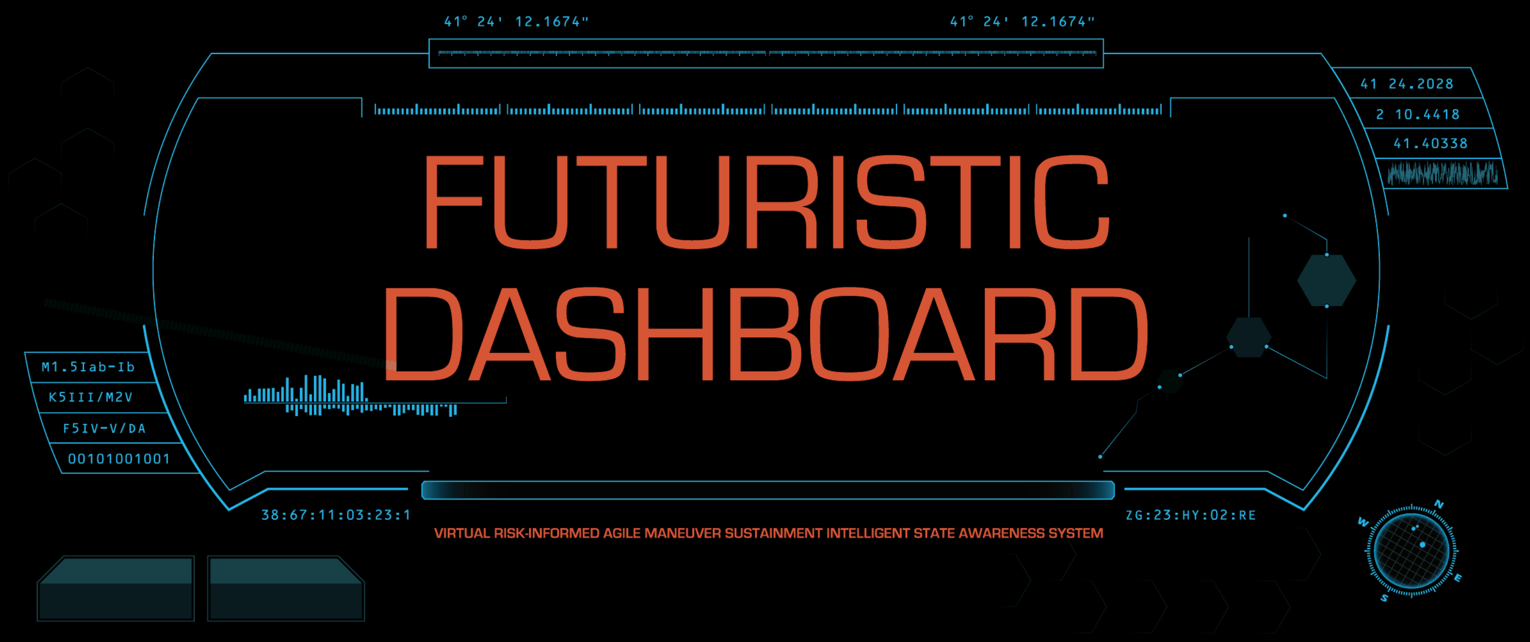
"It would be hugely beneficial if maneuver commanders could deploy for 30 to 90 days without worrying about maintenance, except for battle damage," Miller said.

Today's deployed rotorcraft may spend hours being inspected and maintained after each day's operations. Parts like turbine blades require inspection every couple hundred hours. Miller seeks at least 300 hours of no maintenance and, ideally, synchronized with the planned upgrade schedule.

Miller works with the Army Research Laboratory to integrate their fatigue-free platform concept with zero-maintenance. ARL is developing techniques to detect micro-cracks and other damage pre-cursors before they become problems. They are building a better understanding of fatigue so planners can modify how aircraft are flown to extend their remaining useful life. ARL is also developing a concept for Virtual Risk-informed Agile Maneuver Sustainment, or VRAMS, (see page 14) to provide real-time predictive health monitoring and assessment to the crews and the commander.

Researchers said there is a good deal of collaboration among the six focus areas, especially in basic science and the tools for simulating and predicting performance of rotorcraft and systems.

"We are maturing technologies to maintain the relevance of our current fleet and develop technologies to support the future fleet," Graves said. "Our goal is to provide the Army with the decisive edge and support our Soldiers." ■



FUTURISTIC DASHBOARD

VIRTUAL RISK-INFORMED AGILE MANEUVER SUSTAINMENT INTELLIGENT STATE AWARENESS SYSTEM

Advanced dashboard may change the future of Army aviation

BY T'JAE ELLIS, ARMY RESEARCH LABORATORY PUBLIC AFFAIRS

A futuristic dashboard could change the way Army aviation operates, allowing for autonomous location tracking and updates on the health of an aircraft even at the material level.

Army Research Laboratory scientists are conceptualizing technologies to deliver a more accurate and real-time view into aircraft operations of the future.

Today's black boxes capture basic flight operational information and are not for real-time monitoring. However, possibly three decades from now, Army researchers hope to provide automated real-time solutions for aviators to safely complete their missions, according to Dy Le, an ARL division chief who specializes in sciences for maneuver.

"It's an integrated capability designed to automatically gauge changes in air, ground, and autonomous systems vehicles' functional state at the material level; assess vehicles' maneuvering capabilities taken into account of measured functional state in the context of upcoming or even ongoing missions; and enable operators or Soldiers to maneuver accordingly to achieve mission requirements," Le said.

Dy Le

The system is called VRAMS, or the Virtual Risk-informed Agile Maneuver Sustainment Intelligent State Awareness System.

Total awareness of location and status of all air assets would provide Army commanders with enhanced situational awareness and the decisive edge. But researchers are also aware of the importance of protecting this information.

"This is one of the challenges that we will be working on as we progress through various stages of VRAMS maturation," Le said. "Data/information assurance to protect aircraft position/identity is one of critical pieces to safeguarding the national aviation infrastructure from real cyber attacks."

The dashboard framework would depend on technologies that currently do not exist but would help air traffic controllers, maintenance teams and commanders detect real and potential system and component damage of aircraft.

The concept was inspired by Dr. Bill Lewis, U.S. Army Aviation and Missile Research, Development and Engineering Center Aviation Development director, whose desire was to have fatigue-free aircraft to protect from aircraft catastrophic failures, as well as to reduce operation and sustainment costs.

The project hopes to achieve the Army sustainment goal, for example, zero-maintenance, by containing or eliminating aircraft structural fatigue using the VRAMS Intelligent State Awareness System.

FUTURE VERTICAL LIFT MAY USE VRAMS

Researchers envision VRAMS for the next generation of Army aircraft, known as Future Vertical Lift, in about 2048.

"The current or legacy platforms currently do not have avionic infrastructures and capability that can accommodate VRAMS technology," Le said. "Legacy aircraft can be retrofitted with VRAMS in the future but it would be much cheaper to do it on new or next generation aircraft."

The researchers are also looking at how they can give commanders more flexibility in how they receive and use the VRAMS data.

"VRAMS can provide essential and strategic information in commanders' hands through a hand-held device to monitor the Army aviation fleet and make the most effective decision to meet mission requirements even when logistical support slows," Le said.

SYSTEM CONCEPT INSPIRED BY BIOLOGY

The idea of an aircraft self-healing may sound like science fiction, but Army researchers are pursuing the technology.

"Self-healing capability is envisioned for new aircraft and is a separate technology from VRAMS," Le said.

Le uses a bio-inspired analogy to describe how VRAMS would act as a brain with sensors throughout the aircraft acting as a nervous system.

"We envision dynamic feedbacks and self-learning, or artificial intelligence, to sense, detect, assess and act to preserve the integrity of the aircraft," Le said. "This would all be done autonomously."

The first breakthrough, discovered by the ARL Sciences for Maneuver research team in January 2014, was the identification and capturing of the change in the material (material damage precursor) at microscopic levels before the onset of potential damage.

"The ability to identify and capture material damage precursors is one of key technologies included in the VRAMS core engine," Le said. "VRAMS is envisioned to enable bio-inspired capability, like a pin prick on a finger. You'd recognize that it hurt, you'd feel the pain but there's little that needs to be done to treat it or address it."

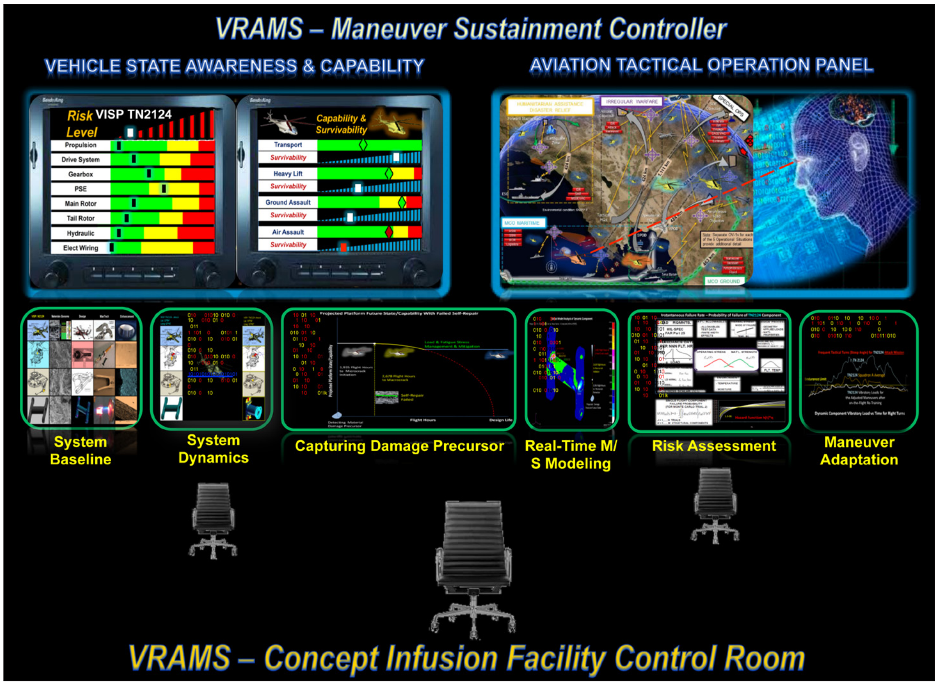
Army future vertical lift aircraft will have multifunctional capabilities. Future aircraft structures will sense damage, access the severity of degradation, and repair it to bring the structures back to a full or acceptable operational healthy state.

"VRAMS can also potentially alert Army pilots of certain severe maneuvers to avoid so operational stress can be kept at or below an acceptable level to avoid the structural fatigue," Le said. "Without being severely stressed or experiencing structural fatigue, the aircraft can last longer than its design life."

RESEARCH PARTNERSHIPS

In the past, University of Illinois researchers and ARL scientists demonstrated the concept of a micro vascular network, much as in human physiology, embedded with capsules containing self-healing agents for repairing composite material damage.

When damage like a micro-crack is detected in a structural component, for example,



The Virtual Risk-informed Agile Maneuver Sustainment Intelligent State Awareness System, or VRAMS, is a complete concept that may change the future of aviation. (U.S. Army graphic)

self-healing agents in the capsules would be released to heal or repair the damage.

ARL researchers are working closely with Navy researchers to develop smart material modeling using material databases while exploring the potential for built-in sensing capability in aircraft structures. VRAMS relies on real-time multiscale modeling to project the growth of damage and degradation.

ARL researchers are also focusing on capturing incoming information from an aircraft's on-board intelligent system and converting them into a binary format so a computer can prepare input files to execute multiscale modeling in real time autonomously.

The results provide information on how long it may take for a material damage precursor to evolve through various stages of damage and grow to catastrophic failure, if the self-repair capability fails to fix the degradation.

"It's like a brake on a car," Le said. "On the highway, the brake life generally lasts longer versus driving a car on city streets, resulting in shorter brake life, because brakes are used more often to stop for pedestrians, traffic lights, and emergency vehicles for example. [We] aim at developing another capability, incorporated into VRAMS, which can determine what maneuvers will reduce the life of the vehicle."

Le said the system concept would include a capability that looks at load and fatigue stress management and mitigation through maneuver adjustments, algorithms can gauge if the aircraft is flying at, above or below certain stress factors like degree of turn.

The concept is getting support from aviation experts across the government, including the FAA and NASA. Identifying technology gaps to make the concept a reality was a major reason for a workshop at Aberdeen Proving Ground, Maryland in August 2014. About 80 aviation experts attended from government agencies, academia and industry.

The ARL team is looking for ways to turn their ideas into technologies that can be tested as early as summer 2015. ■

Editor's note: Dy Le, the mechanics division chief at the U.S. Army Research Laboratory Vehicle Technology Directorate, is the VRAMS architect and ARL sustainment focus lead. He completed pilot training at Fort Rucker in the 1970s and, in 1986, began his career at the Naval Air Propulsion Center and subsequently at the Federal Aviation Administration William J. Hughes Technical Center for 23 years focusing specifically on aircraft systems and components as well as monitoring technologies including the Health and Usage Monitoring System before joining the Army Research Laboratory in 2008.

Mark Calafut works for the Intelligence and Information Warfare Directorate of the U.S. Army Communications-Electronics Research, Development and Engineering Center at Aberdeen Proving Ground, Maryland. (U.S. Army photo by Conrad Johnson)

THE FUTURE OF AIRCRAFT SURVIVABILITY

Building an intelligent, integrated survivability suite

BY MARK CALAFUT, U.S. ARMY COMMUNICATIONS-ELECTRONICS RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

The interconnected world of electronic systems provides an opportunity and a challenge for Army Aviation. As the Army develops its next-generation survivability systems, it has the opportunity to cost-effectively leverage advanced commercial electronics and integration technologies. However, it also faces the challenge of maintaining its technological edge, because many of those same commercial electronics are available to potential adversaries.

Today, Army aircraft are protected by a collection of survivability technologies, including onboard electronic survivability systems. Each onboard survivability system is designed to be independently effective at detecting or defeating a specific class of weapon systems, such as electro-optic and radio-frequency guided missiles or ballistic munitions. When adversaries employ these weapon systems against Army aircraft, the appropriate onboard survivability system automatically detects and defeats the threat, protecting the aircraft and crew.

Historically, onboard survivability systems were designed and developed independently. As technology matured and new weapon systems emerged, the Army upgraded existing survivability systems, or in some cases, added entirely new survivability systems to the aircraft. Instead of a truly integrated survivability suite, the result is a piecemeal approach whereby modern aircraft are protected by a collection of proprietary systems, often developed by different contractors and generally not built with open architectures that would much more readily enable their interoperability.

This presents disadvantages. Although many onboard systems require common components, the independent design and development of the systems prevents components from being centralized and shared. The independent designs came from systems not developed from a systems-of-systems approach with an open standard that established a technical vision for interoperable systems. In many cases, this leads to duplication of components, such as processors or displays that would be unnecessary if the systems were integrated. However, the present lack of integration also prevents onboard systems from communicating with one another and operating cooperatively, which limits reliability and adaptability. For example, if a single protection system fails or is destroyed, the other onboard systems cannot intelligently compensate for that loss.

SMART ALGORITHMS

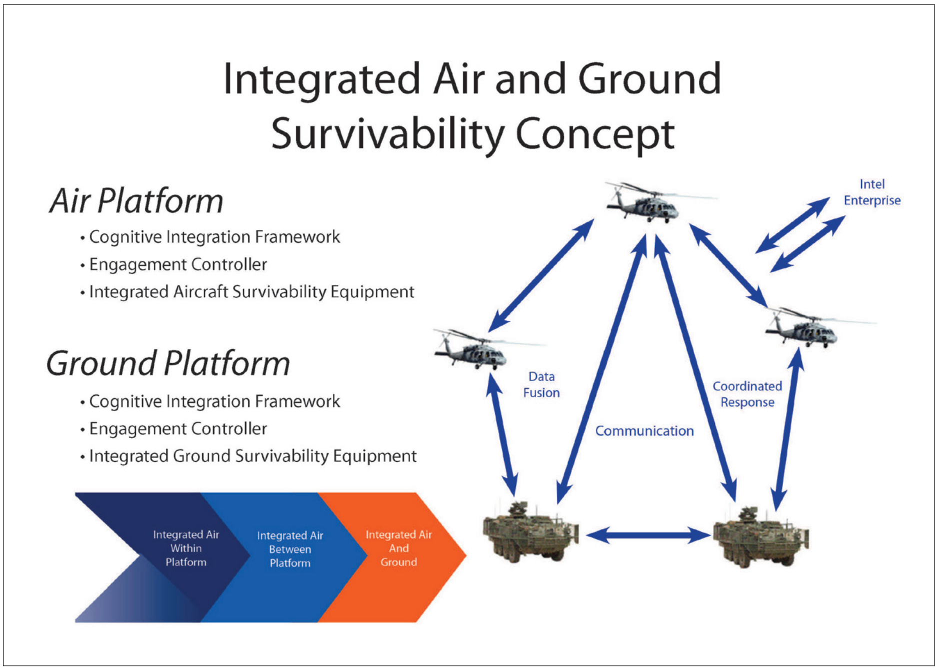
The potential benefits of integration are striking and go beyond merely addressing existing limitations. Modern networked electronics can implement cutting-edge intelligent algorithms to coordinate activities and adapt to new environments. Similar intelligent algorithms already are in use commercially, enabling smart devices to recommend activities and products by combining information from multiple sources and then connecting a particular combination of characteristics to a product. These algorithms use all available information and systems to make smarter decisions for the user.

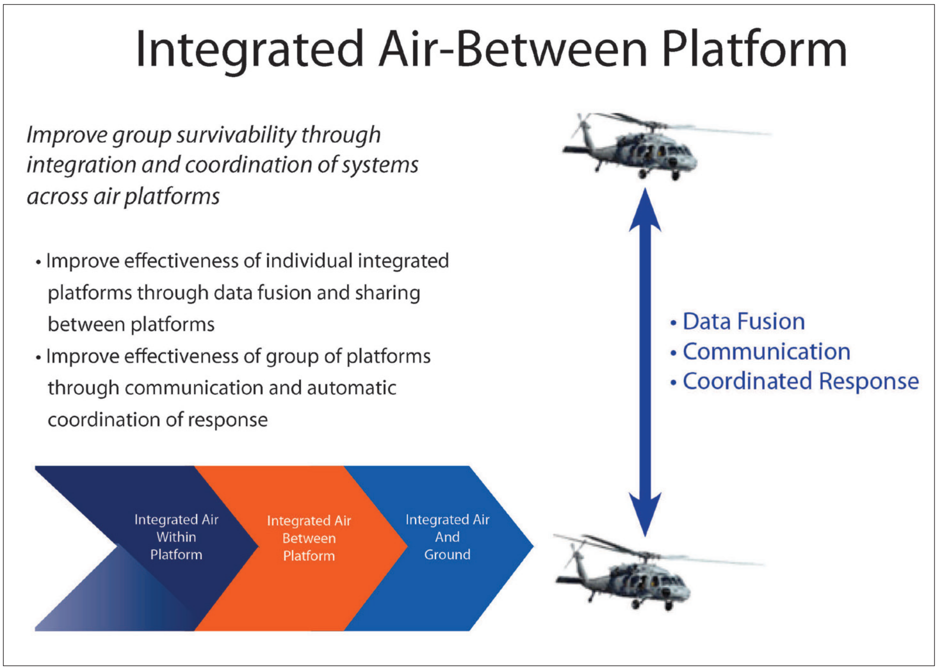
For example, if your smartphone recommends that you try dinner at a popular new restaurant, it may have "considered" elements of your personal history, such as your current location, recent searches on your laptop and shows you watched on your smart TV, as well as external information, such as the current weather forecast and restaurant reviews from other customers. Intelligent algorithms then make the connection between your particular combination of attributes and the new restaurant. If Army survivability systems were appropriately integrated, similar intelligent algorithms would enable networked systems to combine and share data across platforms, calculate and assess risk, and autonomously coordinate the best response to a threat.

Although the potential benefits of integration are significant, implementation faces many challenges, the first of which is technical. Existing systems were not designed to be integrated and do not share common interfaces and standards.

The second challenge is programmatic: Developing electronics in a piecemeal fashion is less complex and requires less coordination between organizations. The last of these challenges is systemic: The Army acquisition process does not provide an overarching technical framework that would require different program offices and technical areas to develop systems in concert with one another, using common components and open architectures, and transferring and sharing technologies that should be used together in disparate systems.

To overcome these challenges, the Army science and technology community is redefining the concept for survivability from a systems level to a holistic or system-of-systems perspective. From this broader perspective, the S&T community envisions a next generation of intelligent systems that work together to protect the aircraft and provide Army Aviation with a powerful opportunity to reduce costs, increase effectiveness and enhance survivability. These systems employ modular and open architectures that simplify integration and enable rapid component upgrades as technology advances.





THE VISION

The U.S. Army Communications-Electronics Research, Development and Engineering Center has established Integrated Air and Ground Survivability as a strategic focus for its S&T programs.

This optimizes total platform survivability through the integration and coordination of individual systems, groups of systems and platforms. The effort's long-term vision establishes an intelligent survivability suite capable of coordinating all survivability systems' activities on the battlefield, with the ultimate intention of coordinating distributed platform-agnostic systems to implement the optimal countermeasure.

The integrated air and ground survivability concept allows CERDEC to overcome implementation challenges and plan unified S&T efforts in the electronic warfare and aircraft survivability domains. Although some S&T programs focus explicitly on integration objectives, many programs focus instead on specific systems or technologies. The integrated framework allows the Army S&T community to categorize and conceptually orient programs with respect to the greater aircraft survivability picture, and allows decision-makers in turn to better assess how well current investments address long-term objectives.

Historically, survivability in the presence of a threat has been characterized as a series of stages. The first stage is to avoid detection by the threat. If the aircraft cannot be detected by the threat, survivability is ensured. However, if it is impossible to avoid detection, the next stage is to avoid engagement. If the aircraft can be detected by the threat but not engaged, survivability is again ensured. When it is impossible to avoid engagement, the next stage is to avoid or absorb damage to the aircraft. Finally, when it is impossible to avoid damage, the last stage is to avoid destruction of the aircraft. A variety of survivability systems and technologies address each stage of this hierarchy.

Rather than seeing survivability systems as independent entities, the Army's integrated approach envisions battlefield survivability systems holistically, as a distributed, coordinated network of capabilities. When Army aviation encounters threats, every networkable asset on the battlefield would leverage information across distributed sources to autonomously collaborate to avoid detection and engagement and subsequently avoid damage and destruction. The network would employ intelligent algorithms at each stage to access information from all survivability systems on the battlefield, as well as from the intelligence enterprise across the Army, DOD and intelligence community. If detection cannot be avoided, the intelligent network would use all available information to locate and identify the threats. The intelligent network would then prioritize the threats, consider available resources and implement optimal countermeasures for each threat. Getting to that holistic capability will be incremental.

The first stages are to share information and coordinate between the survivability systems on the aircraft. The next stage is to bring in information from other on-board sensors. Subsequent stages are to share information and coordinate between platforms and different assets. The initial software architecture is intended to be extensible to build the foundation for this long-term vision.

HIGH-LEVEL ARCHITECTURE

Under the integrated air and ground survivability concept, the future survivability suite is no longer a collection of stove-piped capabilities, but instead a distributed and integrated network of systems across individual air and ground platforms. These systems communicate autonomously with other onboard systems as well as with systems on other platforms.

At the single platform level, the future integrated air suite is coordinated through

Testing Ballistic Vulnerability

Gathering data on Army small aircraft ARL PUBLIC AFFAIRS

The U.S. Army uses aircraft for many purposes, including small-cargo shipments, reconnaissance, training and transportation. Many of these aircraft have limited protection from ballistic threats, and when it comes to the ballistic vulnerability of engines in these types of aircraft, specifically the PT6A, there is little to no data. The PT6A is a turboprop engine used on the Army's fixed wing C-12 aircraft. The U.S. Army Research Laboratory has been working on a project sponsored by the Office of the Secretary of Defense to characterize the ballistic vulnerability of the engine.

The project, part of the Joint Live-Fire Aircraft Systems program, run out of the Office of the Director, Operational Test and Evaluation, is being conducted at ARL's Survivability/Lethality Analysis Directorate facilities at Aberdeen Proving Ground, Maryland. Army researchers have already completed the first of the project's two phases, where they assessed the degree of physical damage from impact and penetration to determine its effect on engine performance.

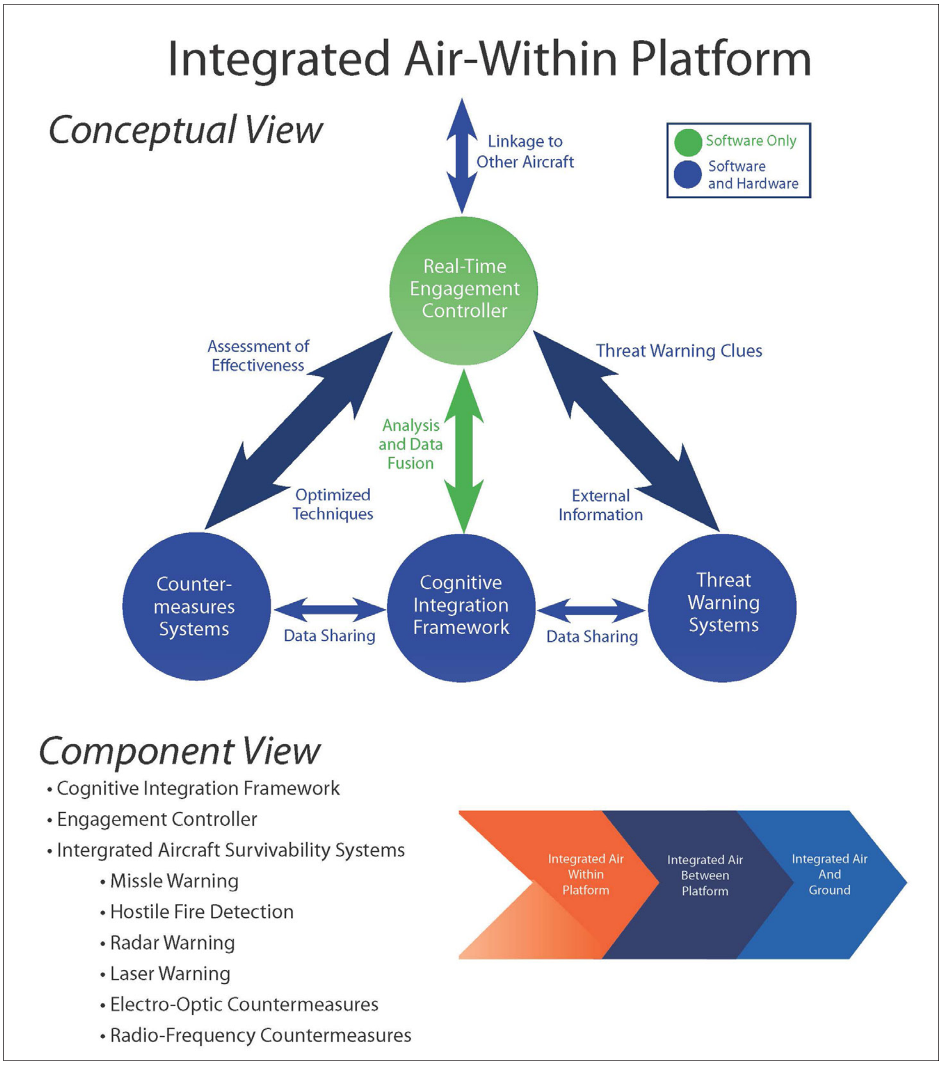
The first stage is to share information and coordinate between the survivability systems on the aircraft. Phase I also examined the effects produced by ball and armor-piercing incendiary threats and fragment-simulating projectiles against unloaded, non-operating components of the PT6A engine.

During phase II, which began last year, ARL conducted 19 ballistic tests against components of a non-operating PT6-34 engine. Phase II also included 31 controlled-damage tests and three ballistic tests against operating PT6A-41 engines installed in a ground-tethered RC-12 aircraft.

an integration framework and an intelligent engagement controller. The integration framework provides the physical connections between onboard systems and the central processing capability to correlate and analyze data. The intelligent engagement controller is a software application that operates on top of the integration framework and serves as the "brain" of the distributed survivability suite. It has access to data from all onboard survivability systems, including missile warning systems, hostile fire detection systems, laser-warning receivers, radar-warning receivers and electro-optic and radio-frequency countermeasure systems. The application continuously assesses data from the onboard survivability systems to detect potential threats; it is implemented with an open software architecture that enables new data sources to be incorporated easily into the existing framework. As the platform encounters threats, the intelligent engagement controller uses advanced cognitive algorithms to locate and identify threats; it then designs optimal countermeasures. In effect, the algorithms identify and implement the sequence of actions that maximize the survivability of the platform, given the unique parameters of the engagement.

At the platform level, individual survivability suites are integrated into a network that continuously shares information and access to resources. The intelligent engagement controller on each platform incorporates information from other platforms when assessing and locating potential threats. Following the identification of threats, the individual suites collaborate to implement a coordinated countermeasure response, leveraging assets from all available platforms.

In the long term, the network of integrated air systems is also integrated with a corresponding network of integrated ground survivability systems. The overall network is connected to external resources, including assets from the intelligence enterprise, enabling air and ground survivability systems to collaboratively detect, identify and defeat threats encountered on the battlefield.



CONCLUSION

Developing the future survivability suite involves continuously balancing investment priorities. With potential threat weapons and technologies, the Army must decide how to invest most effectively in these systems and technologies to affect overall survivability with given budgets and resources. Over the next decade, the Army will continue to stay ahead of threat weapon systems by investing in critical component technologies and integration efforts, such as those that are establishing common interface specifications and common control software.

But what do we do with our systems once they are interoperable? How do we intelligently coordinate these systems—whether they are on the same aircraft or distributed across the battlefield—to make better real-time decisions? And what benefit can this "intelligent integration" ultimately have for platform survivability? That's what we, as an S&T community, are trying to build toward and demonstrate over the next several years. A major part of that path is interoperability, but it's almost a step in the vision rather than the vision itself.

Over the next five years, the Army S&T community is expected to reach a major milestone, completing a new generation of cutting-edge intelligent algorithms and technologies that have never been used in this application. This milestone marks a major first step in establishing an integrated survivability suite, demonstrating the powerful benefit of intelligent algorithms for aircraft survivability. Overall, the focus on integrated air and ground survivability will ensure that the next generation of Army survivability systems remains at the forefront of capability and technology. ■

Editor's note: Mark Calafut works for the Intelligence and Information Warfare Directorate of the U.S. Army Communications-Electronics Research, Development and Engineering Center at Aberdeen Proving Ground, Maryland. He has a master of science in electrical engineering from Stanford University and a bachelor of science in economics from Swarthmore College. He is Level III certified in engineering and is a member of the Army Acquisition Corps.

MAN-PORTABLE AIRCRAFT SURVIVABILITY TRAINER

New training system helps aircraft crews defend against ground-fired missiles

BY ERIC KOWAL, PICATINNY ARSENAL PUBLIC AFFAIRS

Engineers at Picatinny Arsenal have developed an advanced system to train aircraft crews to protect aircraft and crewmembers against threats such as shoulder-fired, surface-to-air missiles.

Since the Vietnam War, such anti-aircraft missiles, especially those known as man portable anti aircraft missiles or MANPADS, have played a critical role in the shooting down military aircraft and their crews.

In order to enable aircraft and crews to survive these missile threats, the U.S. military has developed and deployed a continuously improving suite of aircraft survivability equipment, or ASE assets, that include electronic jammers, lasers and countermeasure flares.

These ASE assets have proven to be very effective at decoying or destroying these threat MANPADS, said James Wejsa, chief of the Pyrotechnic Technology and Prototyping Division of the U. S. Army Armament Research, Development and Engineering Center at Picatinny Arsenal, New Jersey.

However, there has been no significant development and deployment of any realistic improvements in aircraft MANPAD threat training. That is about to change, as Army researchers complete the new system called Man-Portable Aircraft Survivability Trainer. Picatinny engineers said the system is entering the production and fielding support phase.

"This is a realistic training system that we are very excited to be a part of developing and fielding for use in training our aviators," Wejsa said. "These MANPAD threats are real and very deadly to combat and combat support aircraft if not properly protected."

The training system allows aviators to train in a more realistic missile engagement environment and improve their ability to detect and avoid threat missiles.

"The net result is increased aviator readiness and subsequent survivability for the crews and their aircraft," Wejsa said.

The trainer resembles a shoulder-fired surface-to-air weapon. Engineers designed the system to electronically stimulate the aircraft's missile warning system, which may dispense countermeasure flares and activate other aircraft survivability systems.

The trainer records video for after-action reviews to supplement pilot training, and to help aircraft crews to train in detecting, evading and countering missile engagements.

Before, training required trainees to act as role players, Training scenarios had the opposing force use spent Soviet-era MANPADS hulls that were modified with

A Soldier uses the Man-Portable Aircraft Survivability Trainer as an M176 Pyrotechnic Simulator launches in the background. (U.S. Army photo)

A Soldier prepares a simulator, which launches a self-consuming pyrotechnic pellet up to about 550 feet. (U.S. Army photos)

a Multiple Integrated Laser Engagement System or MILES.

The older training system used a type of unrealistic local flash with a loud bang and a small flash and provided absolutely no aircraft survivability equipment or beneficial training for the pilots, Tate said.

With the new trainer, an actual training round simulating a MANPAD missile is fired, sending a smoke trail through the air. The Common Missile Warning System notifies the pilot that a missile engagement has occurred.

The part of the system that provides the pyrotechnic signature to simulate a missile launch and contrail approaching the aircraft is called the Weapon Effects Signature Simulator, or WESS.

The simulator launches an M176 self-consuming pyrotechnic pellet to about 550 feet.

The result is a continuous, concentrated smoke cloud from the ground to a safe altitude simulating a MANPADS contrail signature and a visual stimulation for both the helicopter crew as well as ground forces.

The entire WESS system is lightweight and can easily be carried one Soldier, and small enough to be thrown into a backpack.

Also, because of the visual signature, if there are multiple helicopters in a convoy, one can move in to attack the ground threat, call in ground troops to attack the threat, or they can just evade the scene to avoid the threat.

"Without the visual effects of the M176 pyrotechnic pellet, the helicopter crews would not see where the threat was coming from and would just get an audio alarm from CMWS notifying them that they were fired upon," John Verdonik, project lead, Pyrotechnic Division, ARDEC said.

This older training scenario would not provide a realistic training scenario as the crews cannot either evade or attack a threat they cannot see, he said.

"With the M176 smoke trail, the aviation crews also train to get use to reacting to the realistic sight of being fired upon by MANPADS," Verdonik said.

Without the visual realistic effect in training, the first time the aircrews would see the smoke contrail of a MANPADS attack would be in theater of operations.

"Seeing the missile attack for the first time in a real threat environment is the worst-case scenario because vital seconds would be wasted recognizing the attack for what it is," Verdonik said. "Those seconds could be the difference between life or death."

Also integrated on the Man-Portable Aircraft Survivability Trainer is the Multiple Integrated Laser Engagement System, which notifies trainees how many injuries or deaths occur would have occurred, or if the missile is evaded.

"Right now there is no realistic training," said Verdonik. "That is one of the biggest threats. They (aircraft crews) are dependent on counter measure flares. As a Soldier you don't want to be in theater and see this for the first time. The realism of training will help prepare for real-life threats. The Army motto is, 'Train as we fight.'"

The Pyro Division recently earned a Type Classification Standard of the M176, the process that ensures the materiel is acceptable for production and U.S. Army use before being cleared for full materiel release.

The project is a joint effort ARDEC's Pyrotechnics Division as well as Project Manager Aircraft Survivability Equipment and the Program Executive Office for Intelligence, Electronics Warfare and Sensors and PEO Simulators and Training. ■

ORGANIC RESUPPLY

Aerial resupply lands on ground troops

BY JEFF SISTO, NSRDEC PUBLIC AFFAIRS

Above: Soldiers prepare to the Enhanced Speed Bags System, or ESBS, from a helicopter during the Army Expeditionary Warrior Experiment Speed Bag Operation held Jan. 28, 2014, at Fort Benning, Georgia. (U.S. Army photo by Patrick A. Albright)

Below: Sgt. 1st Class Nicholas Ash, an instructor at the U.S. Army's Mountain Warfare School and a member of the Vermont National Guard, assembles the Enhanced Speed Bag System, linear brake assembly while training at the Rhode Island Air National Guard base in Quonset Point, Rhode Island. (U.S. Army photo)

The U.S. Army is streamlining efforts to provide squad- and platoon-level ground Soldiers operating in austere environments with an organic aerial resupply capability that will empower and sustain them on the battlefield.

The Enhanced Speed Bag System, or ESBS, fills this capability gap by drastically increasing the survivability rate of critical resupply items such as water, ammunition, rations and medical supplies, which must be air-dropped from helicopters to small units on the ground. The system includes a hands-free linear brake, rope, and a padded cargo bag that can hold up to 200 pounds and be dropped from 100 feet.

ESBS was originally developed by engineers from the Natick Soldier Research, Development and Engineering Center's Aerial Delivery Directorate and the Armament Research, Development and Engineering Center's Logistics Research and Engineering Directorate to standardize the improvised airdrop methods used in theater to resupply units in remote locations where traditional resupply methods, such as truck convoys, are too impractical or threat laden.

"The goal was to standardize ad-hoc techniques used with body bags and duffle bags by providing a material solution and giving units enough knowledge and training to utilize it," said Dale Tabor, NSRDEC's Aerial Delivery Design and Fabrication team leader.

"We originally received this need from the field, specifically for emergency ammunition resupply," said Bob Forrester, an engineer with ARDEC's Logistics Research and Engineering Directorate at Picatinny Arsenal, New Jersey. "We received the requirements, found the funding, and teamed with Natick as the technical lead.

"Essentially, we worked the ammunition survivability piece, and NSRDEC worked the aerial delivery piece," Forrester said.

At an evaluation conducted in July 2013 at Fort A.P. Hill, Virginia, teams packed six ESBS cargo bags with 12,720 rounds of ammunition, each distributed based on a squad-level basic load, and dropped from a 100-foot crane. They thoroughly inspected the rounds and conducted a live-fire to determine the ammunition system's effectiveness.

The Enhanced Speed Bag System, or ESBS, is a low-cost, materiel technology solution developed by NSRDEC and ARDEC that uses padded cargo bags, which help increase the survivability of Class V munitions up to 98 percent during aerial re-supply missions and provides small units with an organic, rapid resupply capability. (U.S. Army photo by NSRDEC Public Affairs)

The results were a 98-percent survivability rating of ammunition dropped with the ESBS—a vast improvement from the 50-60 percent experienced with ad-hoc methods.

Subsequent evaluation at Army Expeditionary Warfighting Experiment Spiral I 2014, prompted ARDEC to "recommend the immediate fielding of ESBS to deployed Soldiers," Forrester said.

"What we have done is taken resupply to the lowest possible level— the squad and platoon levels," Tabor said. "Soldiers at unit level are trained how to get the system packaged, loaded in the aircraft, and delivered. In this way, ESBS provides an organic resupply capability."

Advancement of the system gained increased momentum through the involvement of the U.S. Army's Rapid Equipping Force, or REF, an organization uniquely chartered to combine requirement validation, acquisition authority and flexible funding under one roof.

REF's mission to "harness current and emerging technologies to provide immediate solutions to the urgent needs and capability gaps faced by Soldiers deployed globally" led it to the ESBS.

"REF received a 10-liner requirement from a unit that needed a safe and reliable way to resupply water and other critical items to ground Soldiers, in a location where traditional resupply options, such as convoys, were not practical due to environmental factors and threats," said REF Project Manager, Todd Wendt. "The unit was aware of NSRDEC's Enhanced Speed Bag System and identified it as a possible technology solution. Upon mission analysis and further market research, REF identified ESBS as a good candidate solution."

The ability to directly engage with deployed units and access business practices across the Army's functional areas allowed the REF to facilitate a comprehensive approach to ESBS validation.

"By leveraging an existing Army effort, REF is able to give deployed Soldiers solutions even faster than if we started a project from scratch. This also means we can help our friends at NSRDEC Aerial Delivery Directorate, by getting their design into the hands of Soldiers and collecting operational feedback. It's just one example of how REF can address an urgent need, but at the same time, also help advance a technology and support a big Army solution," Wendt said.

In December 2014, Tabor's team led a Train-Up event at the Rhode Island Air National Guard base in Quonset Point, Rhode Island. The multi-organizational event included personnel from NSRDEC, ARDEC, U.S. Army Mountain Warfare School, Vermont National Guard, Rhode Island Air National Guard, and the REF. The purpose was to train REF tiger teams and members of the Army's MWS on the proper use and deployment of the ESBS.

The training focused on receiving the ESBS kit, unpacking it, setting up the rigging in the aircraft and learning the packing procedures—skills that will be passed on to Soldiers who will use the system.

The ESBS training will provide the MWS instructors a period of instruction on small unit resupply that meets the needs of mountain Soldiers, while the REF trainers will take the knowledge they gained directly in theater to train units requesting the capability.

"The initial info seemed complex, but today, I definitely feel sufficient to train Soldiers on this system," said Dusty Hunt, training consultant, Rapid Equipping Force, Tiger Team, at Fort Benning, Georgia. "With the old methods, they were losing 50 to 60 percent of the supplies. Finally, there is a good solution in the ESBS, which we will take to Afghanistan to train the unit's trainers."

"We rehearsed on the ground, and conducted a final check for rigging and spotting," said Jason Miller, training consultant, REF, Tiger Team, at Fort Bragg, North Carolina. "From the aircraft, we looked at how the bundles fell and responded to the drop."

In an after-action review, or AAR, the REF trainers had positive and insightful comments about the system.

"We learned that rigging the system is key to a successful drop. So attention to detail in how it's rigged is important," Miller said. "Also, more elaborate communication with the pilot and the aircrew should be explored."

"There were weather limitations, but the job went well," Miller said. "We lost only one water bottle out of more than 240 and additional five-gallon jugs dropped. It was an outstanding result—we had no issues."

"The benefit is the simplicity of it," Hunt said. "You can take a regular Soldier and train them on ESBS, as long as they are comfortable in the aircraft."

"Aerial resupply also means one less convoy needed on the road, and that's a good thing," Tabor said.

The ESBS will undergo further testing throughout 2015. If the system is selected for fielding, a formal program of record, or POR, will be established, and the REF will have met the immediate need.

DESIGNING BETTER PROTECTIVE GEAR

Army advances chemical-biological aviation protection with integrated approach

ECBC COMMUNICATIONS

Chemical-biological protective gear worn by Army pilots and aircrews has evolved to improve survivability in flight.

Engineers at the U.S. Army Edgewood Chemical Biological Center at Aberdeen Proving Ground, Maryland, are putting design at the forefront of new Mission-Oriented Protective Posture gear, known as MOPP, in order to carefully tailor a suit that addresses specific pilot needs during a given air mission.

Army engineers are working on a chemical-biological protective mask that mitigates thermal burden and hydration issues for flight crews that can also fully integrate with specific current and future aircraft.

"With more than 130 different platforms, five different helmets and a variety of aircrew equipment, focusing on one mask design became difficult," said Don Kilduff, an ECBC engineer who has supported JSAM since its inception. "Over time, the program split into different systems to meet the specific needs across the DOD aviation community."

The Joint Service Aircrew Mask, known as JSAM, was initiated in 1999 by the Joint Program Executive Office for Chemical and Biological Defense and the Joint Project Manager for Protection.

The goal of the program is to provide individual respiratory, ocular and percutaneous protection from chemical and biological warfare agents and radiological particulates for pilots and aircrew.

JSAM began as a single program to replace all aviation protective masks for both fixed and rotary wing platforms. But the Services use different platforms and different configurations of support equipment, which presented an integration challenge.

Now there are five JSAM solutions that address platform specific integration and compatibility challenges:

- JSAM Apache: used by the Army on the AH-64 helicopter
- JSAM-JSF: for the multi-service, multi-country Joint Strike Fighter program
- JSAM Rotary Wing: used by all Services on rotary aircraft other than the AH-64
- JSAM for Strategic Aircraft: for heavy, fixed-wing cargo platforms used by the Air Force, Army, Navy and Coast Guard aviation
- JSAM for Tactical Aircraft: for fast-flying aircraft with ejector-seat capability, used by Air Force and Naval aviation

ECBC engineers lead the program management of two JSAM programs: JSAM Apache and JSAM-JSF. Support includes testing, analysis, logistics and systems engineering, as well as program management and lifecycle management.

Kilduff is the product manager for the JSAM Apache. The variant was introduced in 2007 and provided ocular, respiratory and percutaneous protection while addressing the specific needs of the AH-64 aircrew. As PM, Kilduff is responsible for the lifecycle management of the JSAM Apache masks—development, test and evaluation, procurement and sustainment. His team supported test and evaluation through ground evaluation of

The JSAM-JSF integrates with the F-35 life support system and pilot flight equipment to provide combined chemical-biological and anti-gravity protection. (U.S. Army photos) the mask with cockpit components, ingress, egress, emergency egress, aircraft controls, field of view and night vision compatibility. Engineers from the ECBC Joint Service Physical Protection Engineering Branch provided test coordination, sizing and fitting assistance, coordination of test events, and recommendations for corrective actions. Kilduff oversees their work and manages program cost, schedule and performance.

When the JSAM was developed, there were some "safe-to-fly" issues with the mask lens that impacted the pilot's field of view. The development contractor, Avox Systems, made adjustments to the lens to maximize the field of view through the helicopter's weapon sighting system. Engineering was completed testing in 2009, and the mask was fielded from 2010 to 2012.

The current version of the JSAM Apache has an additional design feature to allow crew members to quickly don and doff the mask in-flight without removing their helmets. ECBC engineers designed a removable face plate that attaches and detaches from the MOPP hood. The Army is fielding this version to more than 19,000 Soldiers worldwide.

For the next version, the team is reengineering the mask to fit the Apache's new helmet specs. Mask models are being tested with an unfunded request for production. The new helmet is more crash-worthy, Kilduff said.

The JSAM-JSF system has faced a similar integration challenge, but with the added complication of functioning with the Joint Strike Fighter, the world's foremost stealthy, survivable, and lethal multi-role fighter jet that is still in development.

An Apache crew member dons the JSAM during an operations test conducted at Fort Hood, Texas. (U.S. Army photo)

Placed on contract in 2009, the JSAM-JSF is designed to overcome the limitations of legacy respirators, while being designed specifically for the unique capabilities of the JSF (also known as the F-35 Lightning II).

The mask will be a lightweight, CB protective respirator, worn as above-the-shoulder chemical-biological protection by F-35 pilots. When integrated with the F-35 life support system and pilot flight equipment, it will provide combined chemical-biological and anti-gravity protection.

"One of JSAM-JSF's unique challenges is developing the system while the rest of the platform is in different stages of development, including key interfaces, such as pilot flight equipment, helmets, spectacles, laser eye protection, communication systems, ejection seats and life support systems," said Ryan Adams, the JSAM-JSF Product Manager with the ECBC Protection Engineering Division. "Working closely with the JSF Program Office has been critical in maintaining awareness of potential changes that may impact JSAM-JSF, and in solving higher system-level issues that go beyond just JSAM-JSF."

The system is in developmental testing. Adams said the majority of testing will be completed by spring 2015 while testing the first F-35 flights with JSAM-JSF and the chemical-biological ensemble is projected for late 2015, based on aircraft availability.

"When integrated with aircraft and pilot-mounted equipment, the JSAM-JSF will provide combined chemical-biological, hypoxia and anti-gravity protection to all F-35 pilots, including the U.S. Air Force, U.S. Navy, U.S. Marine Corps, and international partners," said Adams. "The JSAM-JSF will allow pilots to perform all mission requirements, with minimal operational impacts, in a chemical-biological environment."

The program is managed by the JPM P, an organization with employees from various service organizations, including ECBC, who have provided systems engineering expertise and product management and test duties. In those roles, they are responsible for managing the overall program, engineering and test activities.

"The aircraft requirements and capabilities are constantly evolving," Kilduff said. "Our work on the JSAM must keep pace with other equipment changes and be fully integrated with the aircraft to keep Soldiers both safe and comfortable." ■

State-of-the-Art Facility

New hangar to increase C4ISR-aviation capabilities BY KRISTEN KUSHIYAMA, CERDEC PUBLIC AFFAIRS

Elements of the U.S. Army will complete and occupy a state-of-the-art research, development and engineering hangar in less than a year that will aid in the support of aviation related projects for the advancement of Command, Control, Computers and Communications and Intelligence, Surveillance and Reconnaissance, known as C4ISR, technologies.

By Spring 2016, elements of the U.S. Army Communications-Electronics Research, Development and Engineering Center are scheduled to move into the 107,000 square foot facility at the Lakehurst Naval Air Station portion of Joint Base McGuire-Dix-Lakehurst in New Jersey.

The U.S. Army Corps of Engineers-New York District Army is overseeing the construction by Pennsylvania-based Bedwell Company.

The hangar will supplement a World War II hangar that has degraded over time and will no longer sufficiently support the mission of the CERDEC Intelligence and Information Warfare Directorate Flight Activity, which will occupy both the current and new hangar spaces for the near future.

Located on the only tri-service joint base in the country, the hangar and immediate surrounding area will include high-bay and low-bay aircraft hangars, aircraft-component maintenance shops, administrative facilities, a fixed-wing taxiway and a rotary-wing landing pad, said Henry Muller, CERDEC Intelligence and Information Warfare director.

The new hangar will allow for increased aviation support by the CERDEC I2WD Flight Activity, which provides total end-to-end aviation support for emerging C4ISR technologies, quick-reaction capabilities to units, and post-production aircraft modifications for program executive offices and project managers.

"The need to get technology in flight and into its intended environment early in the development cycle is evident. Whether a new type of antenna, a heliborne Electronic Warfare system, or a sensor technology destined for use on a fixed-wing or rotary-wing aircraft, the CERDEC Flight Activity must be able to support it all," said Charles Maraldo, CERDEC I2WD Flight Activity director.

In addition to CERDEC I2WD Flight Activity employees occupying the hangar, some employees from CERDEC's Space and Terrestrial Communications Directorate, Command Power and Integration Directorate, and Software Engineering Directorate, and the Communications-Electronics Command will also work in the hangar.

Having a government run, highly-skilled workforce that can support integration and experimentation across multiple programs, allows the cross fertilization of ideas and lessons learned across multiple projects, Maraldo said.

The CERDEC I2WD Flight Activity provides a unique development and integration capability for airborne C4ISR to government agencies, academic institutions or industry partners with valid Defense Department missions, and the increased capabilities and space will allow CERDEC to maintain and expand its support to C4ISR-aviation systems programs, Maraldo said.

The hangar will allow for the continued work conducting integration for all types of electronic systems destined for use on aviation platforms and allow for the maintenance and operations of the aircraft assigned to the CERDEC I2WD Flight Activity to be done safely and efficiently, Maraldo said.

In addition to the contagious 20-mile-wide area of JB MDL, the CERDEC I2WD Flight Activity has access to the restricted airspace over the Atlantic Ocean and New Jersey Pine Barrens. It can also leverage facilities and airfields such as Aberdeen Proving Ground, Md., Fort Belvoir, Va., or anywhere worldwide a mission needs to take place.

The CERDEC I2WD Flight Activity works closely with other CERDEC elements to take advantage of the facilities and resources at APG to work in a cohesive test environment across location boundaries. This allows them to integrate systems and perform modifications at the JB MDL facility; base and execute missions in the aforementioned environment and via robust networking capability connect to the Systems Integration Lab environments established in APG, Maraldo said.

The CERDEC I2WD Flight Activity takes advantage of Phillips Army Airfield at APG by taking an aircraft to APG for evaluation, demonstration or display purposes, and not having to replicate the capabilities and investment already made at the CERDEC Flight Activity at JB MDL, Maraldo said.

The CERDEC I2WD Flight Activity also partners with CERDEC's Night Vision & Electronic Sensors Directorate Flight Activity at Fort Belvoir's Davison Army Airfield. Though the CERDEC I2WD Flight Activity and CERDEC NVESD Flight Activity have different aviation missions, they share resources such as contracts, Army Civilian Pilots, aircraft, facilities and Airworthiness Release boards.

The CERDEC Flight Activities collectively operate a fleet of aircraft maintained in strict accordance with Army Standards. The total CERDEC I2WD fleet includes three UH-60 Blackhawks including a UH-60M, a UV-18 Twin Otter fixed wing aircraft and two C-12 type aircraft, and the CERDEC NVESD Flight Activity has two UV-18 Twin Otters, UH-60A Blackhawk, a YEH-60A and two UAV helicopters.

As the CERDEC I2WD Flight Activity continues moving its mission forward, it is poised to provide another several decades of top-notch aviation support and expertise in its new facilities while teaming with the other Army aviation organizations to provide the maximum benefit to the U.S. Army Warfighter, Maraldo said.

Engineering organization recognizes top army scientist

TARDEC

An Army scientist responsible for developing standards for testing tires will soon receive top honors from the engineering community.

Dr. Paramsothy Jayakumar, a senior research scientist with the U.S. Army Tank Automotive Research, Development and Engineering Center at Detroit Arsenal, Michigan, has earned the SAE International Arch T. Colwell Cooperative Engineering Medal.

Jayakumar is an SAE fellow and a member of the TARDEC analytics team.

SAE International, originally established as the Society of Automotive Engineers, is a globally active professional association and standards organization for engineering professionals in various industries.

The group will honor Jayakumar for his contributions in developing tire test standards and physics-based simulation in the ground vehicle community over the past 25 years. Jayakumar, also won the 2014 James M. Crawford Technical Standards Board Outstanding Achievement Award.

He jokingly added that the award has made him a bit of a celebrity in the community.

"My leadership, colleagues, friends, and family value the award and the recognition and make me feel proud," Jayakumar said. "It also serves as a measure of professional growth in the evolution as an engineer and researcher."

Jayakumar's work has had a long-lasting impact on the ground vehicle community by transforming vehicle durability and mobility assessments from a hardware-based empirical approach to a physics-based simulation approach.

"Dr. Jayakumar's innovations and strong leadership have given the virtual product development community an important tool it needed for durability evaluation and verification," said Dr. Marion Pottinger's, original nomination of Jayakumar for the James M. Crawford Technical Standards Board Outstanding Achievement Award. Pottinger is the retired technical director for Smithers Scientific Services.

"These achievements benefitted the auto industry and the off-road vehicle industry by providing virtual durability verification methods, and means of capturing and solving the physics of complex vehicle-terrain interaction over varying soil conditions," the SAE citation reads.

Jayakumar is a member of the U.S. Army Acquisition Corps, an Honorary Fellow of the Department of Mechanical Engineering at the University of Wisconsin-Madison, and an associate editor for the ASME Journal of Computational and Nonlinear Dynamics. Jayakumar received his master's and doctoral degrees in structural dynamics from Caltech and his bachelor's degree from the University of Peradeniya, Sri Lanka.

Jayakumar will receive the award during the 2015 SAE World Congress, April 21-23 in Detroit.

Army scientists discover how to predict damage in future military vehicles

By Joyce Conant, ARL Public Affairs

Army researchers made an important discovery during metals testing that could impact the way the structural health of current and future military vehicles are deemed "healthy and more efficient."

The discovery may lead to saving time and money, as well as prolonging the life of critical platforms.

"Military structures operating in such environments respond in a nonlinear matter ... they shake intensely, especially in rotorcraft," said Ed Habtour, a U.S. Army Research Laboratory researcher who specializes in nonlinear structural dynamics. "I was studying ways to simulate the dynamic response of structures exposed to harsh vibration loading seen in the battlefield."

The objective is to provide operators with economical and novel health-monitoring technologies for the Army-led Future Vertical Lift program, which aims to replace the service's aging helicopter fleet, and the aircraft of other services, at some point in the future.

With damage precursors, Army researchers Ed Habtour (left) and Dr. Dan Cole, hope to convert the structural skins of aerial vehicle components (wings, blades) into "living" surfaces that could sense, react and adapt to the operational conditions. (U.S. Army photo)

The ARL team's approach uses preventative diagnostics with innovative techniques to evolve current maintenance processes from a manual to an automated approach, Habtour said.

While vibration and nano-mechanical testing on the materials' structures continues, this discovery would not only affect future Army aircraft, but would also help reduce the DOD operational and sustainment costs, and the time it takes for maintenance crews to perform mandatory inspections.

Habtour and Dr. Dan Cole, an ARL materials science researcher, shared their approach to developing the basic science behind damage precursor detection. They are developing novel techniques and methodologies to monitor progression of structural property degradation that can become damage.

Some of the approaches used at the laboratory's Vehicle Technology Directorate include changes in the microstructure, electrical resistivity, acoustic response, localized thermal response, and materials micro-compliance to extract precursors to fatigue crack formation.

"I was using classical nonlinear dynamic theory to simulate the structural response," Habtour said. "There was a small drop in the resonance frequency and an increase in the structural softening over time, but conventional sensors such as strain gages were telling us the structure was healthy."

According to the team, one of the most promising techniques is the materials micro-compliance, which provides explanations to complex mechanical behavior encountered in the field.

Read more at: http://www.army.mil/article/142660

SYSTEMS ENGINEERING IN AVIATION TECHNOLOGY

BY THOMAS HADUCH, DIRECTOR OF SYSTEMS ENGINEERING, RDECOM

Systems engineering is a standard practice for defense acquisition programs. It is a system's life-cycle technical process of translating and transitioning a warfighter need through requirements, design and development; then integration; test and evaluation to verify and validate whether the need has been met; and finally fielding and sustainment.

Systems engineers must maintain a big picture perspective, ensuring design considerations such as human factors, maintenance, safety, producibility and reliability are addressed; more specifically for aviation systems, airworthiness qualification and security certification.

Management of the technical risks associated with system acquisition is also a role of the systems engineer. Systems engineering is the technical glue for the many functions that support design, development and fielding. It also binds the efforts of testers and evaluators and subject-matter experts.

Consider these aviation technology programs managed by the Research Development and Engineering Command's Aviation and Missile Research, Development, and Engineering Center:

- Joint Multi-Role Technology Demonstrator, or JMR TD
- Degraded Visual Environment, or DVE
- Future Airborne Capability Environment, or FACE

Each program is grounded in systems engineering processes, practices and tools.

JOINT MULTI-ROLE TECHNOLOGY DEMONSTRATOR

JMR TD is advancing air vehicle technologies and mission-system architecture implementation approaches critical in preparing for the acquisition of the next-generation rotorcraft. Program objectives include:

- Demonstrate advanced rotorcraft designs that are technologically feasible and affordable with regard to criteria such as speed, maneuverability, and payload capability
- Develop standards, processes and analytical tools that increase software reuse and reduce software/architecture development, qualification and upgrade costs

AMRDEC is working with the U.S. Army Aviation Center of Excellence and joint-service stakeholders to define the concepts of employment and then derive design requirements and platform concepts for the Future Vertical Lift Family of Systems.

Key principles of modularity and open-system architecture, model-based engineering and the Architecture Centric Virtual Integration Process as well as technologies to ensure resiliency and extended military utility life-expectancy of each platform design are being researched for the program.

A crucial output will be to define and describe component interfaces that guide implementation of an open system architecture across the program.

Model-based systems engineering concepts for reducing integration defects through early virtual integration and analysis are also being pursued.

Systems engineering processes have the potential to significantly reduce development and integration costs by using model-based analysis tools in areas such as requirements, timing, resource utilization, safety and security.

Through a series of demonstrations, JMR TD will reduce risk by ensuring standards, processes and analytical tools are in place, and that the government and industry are prepared to use them.

DEGRADED VISUAL ENVIRONMENT

The objective of the DVE program is to assist pilots with situational awareness and aircraft flight control in conditions of degraded visibility. The goal is to develop and demonstrate a total technology solution that integrates sensing, cueing and flight controls.

AMRDEC is collaborating on platform sub-system and component technologies with the Communication and Electronics Research, Development and Engineering Center and the Army Research Laboratory.

DVE engineers, technologists and scientists are also working with USAAC to identify and characterize DVE conditions and solution requirements; however, engineers must also characterize and factor platform-induced environments that impact DVE and potential solutions.

Because DVE design solutions must be integrated onto existing and future platforms, new interface specifications will be required. Verification of technology performance and interfaces, one of the systems engineering technical processes, will use virtual and real testing, necessitating test and evaluation plans.

An outcome of this program will be a technical data package used to award development contracts.

FUTURE AIRBORNE CAPABILITY ENVIRONMENT

The FACE program has developed a common operating software environment architecture and standard that will enable faster integration of software and hardware.

The software environment is hardware agnostic and provides well-defined interfaces for example, open system architecture, minimizing the integration risk associated with new technologies, and in turn, reduces costs.

CONCLUSION

This is systems engineering: the actions, processes, practices and tools.

Because of the complicated nature of aviation platforms, systems engineering is invaluable to improving the probability of technology integration into acquisition programs, whether an existing system or a new start. I strongly suspect other technology development programs are doing these same activities; they simply are not being broached as systems engineering.

The chief systems engineers from across the command and I are collaborating on developing a strategy of enterprise practices, training and tools intended to achieve a degree of consistency in how systems engineering is applied to all technology development projects. At the same time, we will focus on assuring the decisions, instructions and tools add value, not hinder innovation. ■

Editor's note: Also contributing to this column were Charles Catterall (Aviation Development Directorate), Rusty Graves (Aviation Development Directorate), Craig Mosley (Aviation Engineering Directorate), Tom Channell (Engineering Directorate, Systems Engineering Management Division) and Dale Moore (Chief Systems Engineer, AMRDEC).

ARMY TECHNOLOGY

COMING IN THE
May/June 2015
ISSUE

Focus: Future Computing

Dr. Tad Brunyé guides a Soldier participating in a navigation virtual reality exercise at the Natick Soldier Research, Development and Engineering Center. Brunyé , who is on the Natick Cognitive Science Team, is investigating various influences on choices people make when choosing a route. (U.S. Army photo by David Kamm)

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STRENGTH OF THE NATION

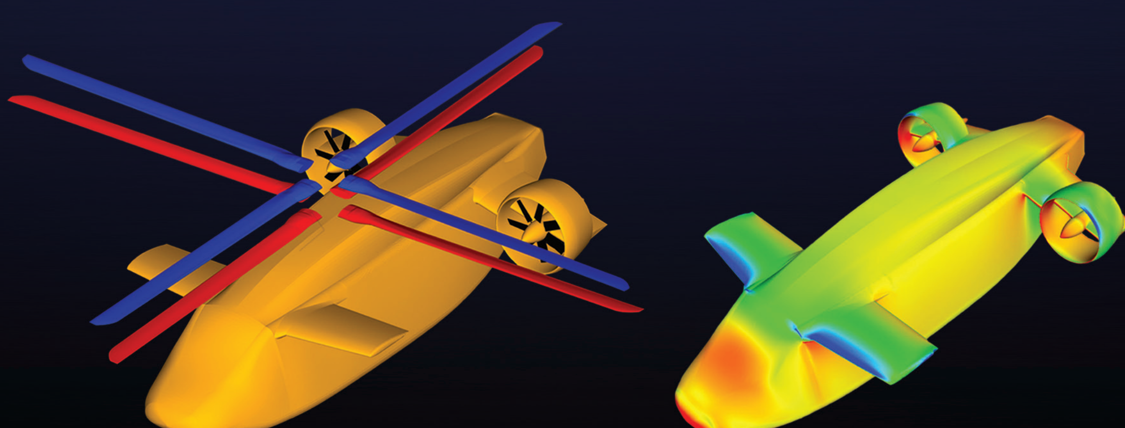
2014 ARMY MODELING AND SIMULATION AWARD

ARMY JOINT MULTI-ROLE – TECHNOLOGY DEMONSTRATOR MODELING AND SIMULATION TEAM

The JMR-TD is a science and technology advance technology demonstrator intended to inform the Army on the "art-of-the possible" for Future Vertical Lift. The joint effort would replace the aging U.S. military fleet with new aircraft that fills technology gaps. Modeling and simulation tools developed by the Army, NASA, and small business and applied by this Army team were used to assess capabilities of the designs proposed for the JMT-TD program. The team's work identified numerous key technology challenges ranging from configuration issues to interactional aerodynamics penalties.

For their work, the JMR-TD Modeling and Simulation Team received the Fiscal Year 2014 Army Modeling and Simulation Award for their support of the S&T JMR acquisition decision at Initial Design and Risk Review.

(Left to right) From the U.S. Army Aviation and Missile Research, Development and Engineering Center: Ernie Keen, Dr. Alex Moodie, Chris Silva, Dr. Mark Fulton, Dr. Hyeonsoo Yeo, Dr. Andrew Wissink, Rohit Jain, Mark Potsdam and Dr. Rajneesh Singh from the U.S. Army Research Laboratory.



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